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REPORT
OF
THE ESSENTIAL OIL ADVISORY COMMITTEE
(EXPLORATORY)

By

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Council of Scientific and Industrial Research

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FOREWORD

It affords us pleasure to know that our exploratory report on the Essential Oils of India has roused considerable amount of interest and the demand for the report has necessitated its further reprint.

We have received a number of suggestions and also some criticisms on the report. We have welcomed the suggestions but the criticisms have not been entirely constructive and have tended to be frivolous. The main criticisms have been that the facts collected by us in the report were not dead accurate. This was inevitable looking to the fact that the report was of an exploratory nature and had to be compiled at great speed from materials supplied to us and which had to be accepted at their face value. We are, however, grateful to several friends for the valuable suggestions they have made on the report and before it is reprinted, we have deemed it advisable to incorporate some of the suggestions. We have also tried to make amends for the typographical errors which had crept into the report.

We are glad to record here that the recommendations in chapter 5 of the report were accepted by the Council of Scientific and Industrial Research in many respects and an Essential Oil Advisory Committee, under the Board of Scientific and Industrial Research, has been functioning since the first publication of the report. It is attempting to implement the recommendation in the Report and we are grateful to the Council and the Board of Scientific and Industrial Research for the sympathetic attention and the systematic encouragement they have given to the work of this Committee.

We sincerely trust that the revised edition of the report will continue to evoke the interest that has already been roused and the Indian Essential Oil Industry will be established on a sound and profitable basis.

20th September, 1946.

P. A. NARIELWALA.
J. N. RAKSHIT.

INTRODUCTION

At the first meeting of the Vegetable Oils Committee of the Board of Scientific and Industrial Research, held at Calcutta in August 1940, the Director of the Board, Sir Shanti Swarup Bhatnagar, raised the question of developing the production of essential oils in India, as due to the war, imported supplies of both essential oils and aromatic chemicals from abroad were curtailed, if not entirely cut off. Since the Committee had before it little or no information about the essential oil trade in India, it "strongly felt the need of setting up an exploratory Committee for surveying the present position of the essential oil industry in the country" and it recommended to the Board of Scientific and Industrial Research the appointment of an Exploratory Committee consisting of--

Mr. P. A. Narielwala—(Convenor).
Mr. J. N. Rakshit—Member.

The Board of Scientific and Industrial Research, at their meeting of September 1940, adopted the above recommendation of the Vegetable Oils Committee and the Government of India were pleased to accept in November 1940 the recommendations of the Board.

We held our first meeting on the 17th December 1940 and as the terms of reference to it were to survey the present position of the essential oil industry in India, we drew up a plan of investigation on the following lines:

(*i*) To require of Universities and other Scientific and Research Institutions in India if any researches were being carried out on:

- (*a*) distillation and commercial uses of essential oils from aromatic plants grown in India.
- (*b*) experimental cultivation of aromatic plants,

  and
- (*c*) recovery of isolates and fixatives from Indian essential oils.

(*ii*) To enquire of the Directors of Industries and of Agriculture of British Indian Provinces and Indian States for:

- (*a*) a list of centres where essential oil-bearing trees, plants and grasses are grown, with an indication of the area under cultivation;
- (*b*) a report on the position of essential oil industry in their respective areas together with statistical information on the production of essential oils and a list of important producers.
- (*c*) result of any industrial researches on essential oil and synthetic perfumes including details any of pending scheme of reseach.

(*iii*) To collect information from:

- (*a*) The Director General of Commerical Intelligence and Statistics on the sea-borne trade of India in essential oils, essential oil-bearing seeds, roots, woods, gums and leaves aromatic chemicals and synthetic perfumes.
- (*b*) The Chambers of Commerce and Industries of India on the quantities of essential oils, aromatic chemicals and perfume compounds imported by their members for their business and their sources of supply.

(*iv*) To prepare a list, if possible, of important indigenous manufacturers of essential oils, attars and aromatic chemicals and to report on their method of work and difficulties if any in developing their industry.

(*v*) To visit and study at first hand the work done at Scientific and Research Institutions on essential oils.

(*vi*) To visit important manufacturing centres in India of essential oils.

(*vii*) To collect and study scientific publications on essential oils of Indian Universities and Research Institutes, and

(*viii*) To recommend measures for developing the essential oils industry in the country on a planned scientific basis.

In view of the extensive nature of the enquiry, we appointed Mr. Charles Goldstein, Chemical Engineer, Strasburg, who has specialised in the manufacture of essential oils and synthetic perfumes, as Honorary Secretary to our Committee, and Mr. P. A. Rao, B. Sc., and Mr. S. Ghosh, B.Sc., as investigators.

A list of persons, institutions and business firms to whom our enquiries were addressed are given in Appendix A of our Report. In addition, Mr. J. N. Rakshit paid a visit to the Rosha Grass Plantation on Chenab, Canal, District Sheikhupura, the Punjab ; the Forest Research Institute, Dehra Dun and the Orange Plantations in Khasi Hills, Assam ; while Mr. Goldstein visited Korla, District Ratnagiri, Bombay, the Agri-Horticultural Society, Madras, The Kerala Soap Institute, Calicut, the University of Travancore, Trivandrum, the Indian Institute of Science, Bangalore, the Tatguni Estate, Bangalore, the Government Sandalwood Oil Factory, Mysore, the Orange Plantations at Nagpur and Coorg and Essential Oil Distillers in the Central Provinces, Cochin, the Nilgiris and the Sheveroy Hills. Mr. P. A. Narielwala visited Kanauj, the centre of "attar" manufacture in India and the Harcourt Butler Technological Institute, Cawnpore.

Our investigations have shown that the essential oil industry in India is widely scattered and, with rare exceptions, is in a primitive state of existence. The bulk of the producers of essential oils in India continue to practise their trade on a cottage industries basis in old fashioned ways, and it is deplorable that although scientists working in India have done a reasonable amount of work on essential oils, yet no attempt has been made to present this information to the cottage producers. In the forefront of the scientific workers was the late Mr. Puran Singh of the Forest Research Institute, Dehra Dun, and he did not only pioneering work in his laboratory, but translated his research into practice by starting an experimental farm for the cultivation of Rosha Grass and distillation of oil, in face of many handicaps and difficulties.

Although we were asked to survey only the present position of the essential oil industry in India, we feel that having investigated the subject, we would be failing in our duty if we were not to make a reference to the subject of aromatic chemicals and also recommend legitimate steps for the development of the essential oil industry in the country on a planned basis. In our opinion no discussion on essential oils can be complete without dealing with the question of aromatic chemicals, a number of which can be derived as isolates from a variety of essential oil produced in India and which today play such an important part in the blending of modern perfumes. We have, therefore, devoted a brief chapter on aromatic chemicals in our report *vide* Chapter No IV) as we are of the opinion that any development of essential oil industry in India must, if not immediately, in due course bring about the manufacture of corresponding aromatic chemicals in India

The present war offers considerable opportunities for the industrial development of the country, and as the last World War was directly responsible for the birth of the sandalwood oil industry in India, as a result of which India has now become the largest producer of sandalwood oil in the world, we feel, as a result of our investigations, that time is opportune for the cultivation of aromatic trees, plants and grasses on a commerical scale and the winning of the essential oils therefrom. If the essential oil industry can be developed on a scientific and planned basis, we visualise a new avenue of wealth for our educated unemployed and a secondary income for our hard pressed agriculturists. We, of course, appreciate that any haphazard development of this industry will only hamper progress, and in our recommendations we have aimed at a co-ordination of work between the agriculturist, other scientific workers, the industrialist and the Government, so that the progress of the industry may be ensured.

Before we conclude, we should like to record our appreciation of the work done at the Indian Institute of Science, Bangalore, the Rakshit Garden Laboratory, Ghazipur, and the Hindustan Aromatics Co., Naini, Allahabad. We also wish to tender our deep gratitude to all those who have helped us in our investigations and in particular we are indebted to Mr. S. G. Sastry, Director-in-charge of the Government, Sandalwood Oil Factory, Mysore, Mr. K. P. Menon, Superintendent, The Kerala Soap Institute, Calicut. Dr. Sadagopal of the Hindustan Aromatics Co., Naini, Allahabad, Prof. Jai Chand Luthra of the Punjab Agricultural College, Lyallpur, Dr. N L. Bor of the Forest Research Institute, Dehra Dun, Mr. M. Carbery, Director of Agriculture, Bengal and Mr. H. S. E. Stevens, Special Officer (Jute), Government of Bengal, for their co-operation and valuable suggestions based on their intimate knowledge of the problems. We also wish to thank Mr. Charles Goldstein, the Honorary Secretary of the Committee; had it not been for his indefatigable labour and his expert knowledge the work of this Committee would not have been completed within a short time.

P. A. NARIELWALA.

J. N. RAKSHIT.

CHAPTER I

A HISTORICAL SURVEY

In the course of our enquiries we have noticed a considerable confusion in the minds of people as to what constitutes essential oils; this is no doubt due to ignorance, but it is regrettable that such a confusion should also prevail in Government Departments, particularly of Indian States, as was evident from the replies to our enquiries. It would not be, therefore, out of place to define essential oil as distinct from fatty and mineral oils. Essential oils are found in aromatic plants and are extracted or expressed from roots, stems, barks, leaves, flowers, seeds and peels. Although therefore they are derived from the vegetable realm, they are different from vegetable or fixed oils in being volatile and composed of chemical constituents of a different nature. Chemically they are a combination of substances mainly like Terpenes, Sesquiterpenes, phenols, alcohols, acids, esters, aldehydes, ketones, nitrogen and sulphur compounds, whilst the vegetable or fixed oils are chiefly chemical combinations of Glycerine and various fatty acids.

(2) The application of essential oil is very extensive and covers a large number of human activities. A few important uses, to which essential oils and their derivatives can be put, are in the manufacture of soap, cosmetics, pharmaceutical preparations, confectionery, and aerated waters, disinfectant and detergents, tobacco, incences, etc. Apart from these uses, the people of India have been known from time immemorial to be fond of rich perfumes for their personal use and their religious ceremonies. Mr. S. G. Sastry has stated that the " earliest records of history show that sandalwood was held in great reverence in all religious ceremonies in India and that it constituted an article of barter between India and other Mediterranean countries thousands of years ago. Mention of the Indian " perfumery industry is also found in Sanskrit, Pali and Islamic Books. The Moghul Emperors of India were great patrons of the perfumes of India and Abul Fazl in the " *Ain-i-Akbari* " says:

> "His Majesty is very fond of perfumes. The Court wall is continually scented with ambergris, aloe, and compositions according to the ancient recipes, or mixtures invented by His Majesty, and incense is daily burnt in gold and silver censers of various shapes, while sweet smelling flowers are used in large quantities."

Queen Elizabeth is also reported to have used Indian perfumes, while Mary Queen of Scots, used to get her baths delicately perfumed with them.

(3) Various other workers, during their investigations, have been able to locate in various parts of India a large variety of raw materials of practically all the series of aromatic groups. This is but natural as India is fortunate in having a variety of climatic conditions and soils, suitable for the growth of aromatic plants, herbs and trees. It is not, therefore, surprising that the manufacture of essential oils and allied products was being carried on as a flourishing industry in India from ancient times. The reputation of Indian attars had spread beyond the boundaries of India; places like Ghazipur, Jaunpur and Kanauj were important centres of production and were well-known throughout the world. Unfortunately.

the flourishing position which India had attained in olden times in this industry dwindled down due to lack of scientific knowledge and the inability of the illiterate manufacturers to adapt themselves to scientific advancement, with the result that the essential oil industry in India is today in a deplorable condition and from a position of being exporters of essential oils and attars, India has become a large importer of essential oils, aromatic chemicals and synthetic perfumes.

(4) The systematic and scientific study in the West of essential oils led to the isolation of organic chemicals having pleasant odours. Among the important aromatic chemicals to be discovered were Geraniol, Citral, Citronellal, etc. The logical development of scientific researches on the isolation of odoriferous constituents of various essential oils led European chemists to devote their attention to prepare some of them by synthesis using as starting materials, the derivatives obtained from fractional distillation of coal-tar. The principal cause of the decline of the essential oil industry in India was thus due to the rapid strides that the manufacture of synthetic perfumes had taken in Europe and which the illiterate manufacturers in India failed to cope with, resulting in the flooding of the Indian markets with cheap but invariably efficient synthetic perfumes. When these synthetic perfumes, almost similar to natural essential oils, could be manufactured at considerably lower costs, India not only lost its export markets for its attars and its varieties of essential oils, but its manufacturers of soaps, toilet articles, confectioners, etc. also turned to the synthetic perfumes for use in their products. Further, the development of essential oil-bearing plants—similar to those grown in India—in other tropical parts of the world under Government patronage created surplus supplies of important essential oils, and took away from India the monopoly it enjoyed in them at one time.

(5) The four well-known methods of manufacturing essential oils are :

(*a*) Water distillation,
(*b*) Expression,
(*c*) Enfleurage, and
(*d*) Solvent extraction.

and the process consists of removing the odoriferous substances present in the aromatic plants.

(6) *Water Distillation*.—This process is the most widely used throughout the world, it being the system of heating the materials, soaked in water, under open fire, a system which is found to be still prevalent in almost all the centres in India producing essential oils. This method is, however, a crude method as it affects both the quality and the yield of the oils. On the other hand, a better method would be distillation by steam since it is quicker in operation and gives a better yield and quality of oil and enables the operations to be controlled in a scientific manner. The difficulty of setting up steam distillation units in inaccessible places where aromatic plants grow has largely contributed to the Indian distillers still resorting to the old water distillation method because of it being the cheapest and the most simple for conducting the operation. We, however, understand that the Kerala Soap Institute at Calicut, which has devoted some thought to the problem of improving the distilling methods practised in India, have devised a small distilling apparatus which can be used under open fire but which is said to give better results than the old water distillation method. The water distillation method is suitable for producing oil from roots.

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grasses, leaves, wood and some varieties of flowers; it is, therefore the most popular and universal method employed for the extraction of essential oils.

(7) *Expression.*—This method is utilised, and has been developed particularly in Italy, for the expression of delicate essential oils from the peels of citrus fruits like oranges, lemons, etc. The peels are pressed over sponges from which the absorbed oil is recovered by squeezing with hand. It is no doubt possible to extract the essential oil from citrus peels by steam distillation, but the oil has been found to lack the freshness of aroma which is usually associated with hand pressed oils which fetch a better price.

(8) *Enfleurage.*—This method is employed for extracting the oil from flowers like Jasmine, Tuberoses, Acacia, etc. by allowing the flower to come in close contact with pure fat on specially devised trays. The fat absorbs the odoriferous bodies present in the flowers and when it is saturated with the perfume of the flowers it is shaken with alcohol at low temperatures which dissolves the perfume but practically no fat. This method of extraction was known and practised in India many centuries ago and has been mentioned in "*Ain-i-Akbari.*" It is practised in India even today for the production of scented oils which are generally made from sesamum seeds. Wetted sesamum seeds are placed in alternate layers with the flowers and are left over for 12 to 18 hours; the seeds are then crushed in a mill and the scented oil is obtained. The Indian method of enfleurage is, however, different from the European method where the extract is obtained in a solid form known as "concrete" which consists of the flower oil in solution in natural waxes present in the flowers. From the "concrete" the natural flower oil, often called the "absolutes" is separated by suitable solvents. The "concretes" and the "absolutes" obtained by the enfleurage method are very expensive but are invaluable in the blending of high quality perfumes as well as synthetic flower oils.

(9) *Solvent extraction.*—This process is generally used in recovering oils having a delicate flowery note, which may ordinarily be destroyed under steam distillation. The solvent commonly employed is petroleum ether of low boiling point. The solvent is boiled in a separate vessel, and its vapours are allowed to enter a rotary drum in which baskets, containing the flowers to be extracted, are fitted; these baskets are pierced so that the vapours pass freely through the flowers as well as from one basket to another; by keeping the drum in rotation, fresh solvent comes at regular intervals in contact with the flowers. There is also another method in which the solvent is allowed to pass through a series of vessels, and extraction is carried out by the counter current system in which fresh solvent is allowed to pass over flowers which have already given up most of their perfume by previous extraction. The saturated solvent is evaporated and an "absolute" of the flower perfume is obtained. Although this method has greatly improved lately and has partly replaced the enfleurage method, on account of its rapidity of execution, the quality of "absolute" obtained by the enfleurage method is still considered to be far superior. In fact both the methods are coupled in modern factories in the West and the flowers used in the enfleurage method are subsequently treated by volatile solvents for thorough extraction of odoriferous materials which had no time to dissolve in the fat. As far as our investigations go, this method is not in use anywhere in India.

(10) The production of essential oils in India is still practised by the water distillation method as mentioned above, though in rare cases the method of steam distillation is also employed as in the case of the Government Sandalwood Oil Factory at Mysore. The manufacture of pure natural oils of flowers or "absolutes" of Jasmine, Moghra. Bokul, etc., is practically unknown in India. but the attars of these and other flowers are produced at Kanauj and Ghazipur, where the method of manufacture consists of heating the flowers mixed with water under an open fire in a copper vessel which is connected to a pot containing sandalwood oil into which the vapours are allowed to condense. After the separation of water, the mixture of sandalwood oil and natural flower oil constitutes the attar of India, and the quality of an attar is determined by the concentration of the natural flower oil in it. In Chapter II we have discussed the important attars made at Kanauj where this ancient industry still continues unimpaired due to the traditional customs and tastes of the people of India.

(11) Although the illiterate manufacturers of attars and essential oils remained ignorant of the scientific progress in the West, the importance of the subject was realised by the scientists working in India as far back as thirty years. The late Mr. Puran Singh and Dr. Simpson, both of the forest Research Institute, Dehra Dun, as also the Indian Institute of Science, Bangalore and the Rakshit Gardens Laboratory, Ghazipur, have done a considerable amount of work on examination of numerous aromatic raw materials which flourish in different parts of India under varied climatic conditions. We have come across as many as 172 scientific publications from Indian Laboratories and their list is shown in Appendix B.

For want of time, reference to previous publications by investigators in and outside India, could not be collected for inclusion. It is not possible for us, within the short time at our disposal, to review or summarise the work of these papers giving a variety of natural aromatic constituents, as the investigations, in a majority of cases, are of a preliminary nature. They, therefore, provide little or no data with regard to the availability of raw materiala, their suitability as secondary crops, the prices at which they could be obtained, the cost of extracting the essential oils from them, the uses to which such oils could be put, etc. In fact, no attempt appears to have been made to collect data pertaining to the commerical and economic side and it is not therefore, surprising that no tangible results have materialised from these researches in spite of the work done on them for the last 30 years. We are, however, of the opinion that these papers can form the basis of further organised investigation directed towards scientific, economic and industrial consideration.

CHAPTER II

ESSENTIAL OILS AND ATTARS OF INDIA

(12) In order to apprise the position of the essential oil industry in India, we have been greatly handicapped by lack of statistical information from the Government Departments. With few exceptions the importance of essential oils to the economy of the country has not been recognised or appreciated by the Industries or Agricultural or Forest Departments of the Provincial Governments or of Indian States. This accounts for the total paucity of any statistics on essential oils produced in different centres in India or of the acreage under production of aromatic trees, plants, grasses, etc. For a rapid industrial development of the country, the importance of statistical information cannot be exaggerated and urgent steps should be taken by the Departments of Agriculture and of Industries to make a start with the collection of statistical data that may be of use to the industrialists, the economists and the research students. The only statistical information that we were able to obtain is from the Director General of Commercial Intelligence and Statistics, who has furnished us with figures of exports and imports of essential oils from and into India for the last two-pre-war years. These are shown in Appendix C. This information is, however, not adequate and it should be collected in greater details to enable a closer check being kept on the varieties of materials imported into India and particularly separate figures of aromatic chemicals and synthetic perfumes should be recorded. From the figures of imports and exports of essential oils, as shown in Appendix C, it will be seen that India exports a little over Rs. 20 lakhs worth and imports about 16 lakhs worth of essential oil. A study of the export figures reveal that nearly half of our exports consist of sandalwood oil, and for a large country like India the rest of the export is very insignificant. No account has been taken in these figures of the exports from India of essential oil-bearing raw materials like wood, seeds, roots, flowers, barks and gums or of the imports into India of aromatic chemicals, synthetic perfumes, flavouring essences, etc. In Appendix D to this report we are showing the export of essential oil-bearing raw materials, but we are unable to give any corresponding import figures as they are not available. The Appendices C and D will, however, show that the total trade of India in essential oils and their raw materials, as also of aromatic chemicals and synthetic perfumes,well exceeds a crore of rupees. In order to form an idea of the world trade in essential oils we have attached Appendix E showing the world production of some of the important essential oils and the place which India occupies in it. Except for few items, it will be seen that India takes little part today in this valuable trade and industry, but it shows the possibilities that await India for the development of this industry on account of climatic advantages. These figures are about 7 years old and they may not be entirely accurate today, but they are quoted to give an indication of the enormous leeway India will have to make if it is to occupy a prominent position in the essential oil trade.

(13) The growing of aromatic plants of different varieties in India does not appear to us to present any serious difficulty and in our opinion their cultivation can be developed as a secondary crop. India is fortunate in having climatic conditions varying widely in different localities and the growing demand within the country for essential oils, aromatic chemicals

and synthetic perfumes, due to the development of soap, pharmaceutical and other industries, it should be possible within a few years to make India self-sufficient in these requirements and also to develop a flourishing export trade in them. We understand that out of 170 families of the aromatic plants, not less than 100 can be grown in India without difficulty in various parts, and their cultivation would yield hundreds of perfume-yielding materials. The lot of the agriculturists in India is always a hard one. For nearly half the year he is idle, having no crops to attend to. His lot in the present war conditions is still worse due to the loss of a number of export markets for his produce which has resulted in various restrictive measures on the raising of important money crops like jute, Groundnuts, Cotton, etc. It is regrettable that no consideration appears to have been given to the possibilities of growing aromatic plants, grass, etc., as secondary crops, as they would not only give rotation crops but also provide the agriculturists with a side-income which will be of considerable benefit to them. The agriculturists need rotation crops to maintain the fertility of the soil and in aromatic plants they can have easily cultivable materials. It is not claimed by us that their cultivation can entirely replace the loss sustained by the agriculturists by the restriction or decline of such important crops as poppy, indigo, jute, groundnuts, cotton, etc., but their introduction as a secondary crop will be a move in the right direction and will help to reduce the loss the agriculturist has sustained besides giving rise to the development of a new industry. With the growing demand for essential oils and perfumes in the country the present is the opportune time for the Departments of Agriculture, Industries and Forests to co-ordinate their activities with a view to see to what extent it will be possible to grow important essential oil-bearing plants in India with a view to lessen the dependence of soap, cosmetic, pharmaceutical, confectionery and others similar industries on foreign imports.

(14) The production of essential oils in India is carried out, literally speaking, from north to south, with important centres of production in the Punjab, United Provinces, Central Provinces, Orissa, the Nilgiris, Mysore and Travancore. The important oils, apart from the Indian attars, are as follows:

(*a*) Eucalyptus Oil.
(*b*) Ginergrass Oil.
(*c*) Khus Oil.
(*d*) Lemon Grass Oil.
(*e*) Linaloe Oil.
(*f*) Palmarosa Oil.
(*g*) Rose Oil.
(*h*) Sandalwood Oil.
(*i*) Turpentine Oil.

Small quantities of other oils are also produced in India but there is no proper organised effort and the production is thus spasmodic. A beginning has been made to produce Citrus Oils on a commercial scale in the Punjab and in the Bombay Presidency and of Ajwan Oil at Indore. Similarly, at Kuppam in South India, efforts are being made to distil Patchouli Oil from imported Singapore leaves whilst spasmodic production of

Geranium Oil is reported at Yercaud on the Sheveroy Hills and of Wormwood and Camphor Oil in the Nilgiris. In Mangalore Cinnamon Oil and in Orissa Salresin Oil are being produced by crude methods. We were not able to obtain any figures of production of these oils either from the Directors of Industries or from the manufacturers themselves. Some idea of the production may, however, be had by a reference to Appendix E in which are given the figures of world production of important essential oils and according to which the production of Indian Oils is estimated as follows :

	Tons.
(d) Lemon grass oil	270
(h) Sandalwood oil	70—80
(f) Palmarosa oil	30—40
(a) Eucalyptus oil	20
(b) Gingergrass oil	2—3
(c) Khus oil	3

It may be pointed out that these figures were estimated in 1934 and it is possible that production of some oil has gone up since then, particularly of Sandalwood Oil which has been finding a larger market not only within the country but also for export, and for the manufacture of which new factories are coming up.

(15) A list of some of the important manufacturers of essential oils and attars in India will be found in Appendix F. We should like to mention here the work that is being done on essential oils and aromatic Chemicals by the Hindustan Aromatic Co., Naini, Allahabad, under the expert guidance of their Chief Chemist Dr. Sadagopal. We understand that attempts have been made by this Company to obtain various essential oils by improved methods and to produce, for the first time in India, characteristic Indian flower perfumes, which, we are given to understand, have received recognition in foreign markets. We have heard complaints of lack of support and encouragement from Indian consumers of perfumes like the soap makers to essential oils and blended perfumes produced locally. This complaint is partly legitimate since the perfumery industry in India is in a disorganised state and in the manufacture of the new varieties, numerous factors have to be adjusted before a standard quality is introduced. If the essential oil industry is to succeed, it is incumbent upon the Government and other consumers of essential oils and perfumery materials to give direct encouragement to factories that work on scientific lines and produce new products : without such a support no new industry can take roots and thrive. It may be worth while mentioning the instance of a Company called The Essenflor Products, Ltd., which was started in Mysore after the last war for manufacturing essential oils and aromatic chemicals by modern methods. It was reported to us that this factory was well equipped and it manufactured oils of Ajowan. Cardamom, Cinnamon leaf, Patchouli, Dhavana (a variety of Artemesia), etc., they also recovered Thymol from Ajwan Oil and Eugenol from Clove Oil, but in spite of years of pioneering work, this Company came to grief and disappeared on account of financial troubles.

(16) We shall deal here in greater detail and in alphabetical order with the various essential oils and attars produced in India. In the

introduction to this report we have indicated the lines on which we conducted our enquiries and the attempts we made to collect as much information as possible in order to present a complete picture of the Indian essential oils. The information we detail below has been gathered by us as a result of our investigations and from such literature that was possible for us to collect.

(17) *Ajwan Oil*: (Carum Capticum, Benth).—This oil is obtained from the Ajwan seeds and has use in the pharmaceutical and perfumery industry. This oil is produced at present on a commercial scale at Rao in Indore State; a little of it is also produced in the United Provinces. In Indore the oil is produced by steam distillation and we have been informed that one ton of seeds yields about 56 lbs. of oil. From the oil is also recovered Thymol crystals, after the extraction of which the residue is sold under a new trade name of "Thymoil", The price of Ajwan Oil is Rs. 2-8-0 per lb. whilst that of Thymol is Rs. 6-4-0 per lb. and of "Thymoil" Re. 0-12-0 per lb. All the products from the Indore factory are of excellent quality and with the support of the Indian pharmaceutical and other industries this new industry should be successful and should expand in time, not only during the war but after it also. It is possible that after the war competition will probably arise and it will be the duty of the Central Advisory Committee that we are proposing in our recommendations to direct the activities of this and such other factories on sound judicious lines.

(18) *Camphor Oil.* (Cinnamomum Camphora).—This oil is produced only at the Hallacary estate in Coonoor, where 200 acres were planted with camphor trees (variety Laurus Camphora) 30 years ago. On distillation of the leaves, solid camphor and camphor oil are obtained and at this estate about 500 lbs. of camphor and 150 lbs. of camphor oil are being produced per annum and they find a ready sale in the market. The world production of camphor oil is about 4,500 tons per annum according to Schimmels and it is almost entirely produced in Japan. It takes several years for camphor trees to grow and to be of benefit as producers of camphor and camphor oil, but due to the commercial importance of these products, we are of the opinion that attempts should be made to grow camphor trees on a large scale in various parts of India. We should like to invite attention to the work done by Simonsen on Indian camphor trees; the camphor per cent. in the oil obtained by him from different portions of the tree by steam distillation was as follows:—

Green leaves—40.6 per cent.
Leaves—43.0 per cent.
Dry leaves—30.5 per cent.
Twigs—from 20 to 35.5 per cent.
Branches—from 0 to 12 per cent.
Roots—from 24.0 to 28.7 per cent.
Stumps—from 17.5 to 25 per cent.

After a study of the work done on Camphor trees by Simonsen and others we feel confident that camphor trees can be successfully cultivated in all parts of India with an annual rainfall of 40 inches and over and a satisfactory yield of oil, rich in camphor, can be obtained from the leaves.

The imports into India in 1938-39 of Camphor was 1,868,694 lbs. valued at Rs. 21·88 lakhs and of Camphor Oil about 4,600 gallons valued at Rs. 11,000. It can thus be seen that by the cultivation of camphor trees it is possible to capture this trade and this question, therefore, needs an urgent consideration. We do not understand why no action was taken on the promising results of the investigations carried out by Simonsen on camphor trees as far back as 1928.

(19) *Cinnamon Oil*: (Cinnamomum Zeylanicum). This oil is distilled by a few firms in Bangalore by crude methods from the bark as well as the leaves of the cinnamon trees which grow abundantly in Malabar and South Kanara. The oils from the leaves and the bark differ in their chemical constituents, the oil from the bark being more valuable, though both the oils are of considerable importance in Pharmaceutical industry in the flavouring of foods and manufacture of aromatic chemicals. The oil from the bark is sometimes erroneously known as cassia oil. The confusion seems to arise because Cassia oil is obtained from the bark of cinnamomum cassia and has a cinnamon-like odour and from it (the cassia oil) the important aromatic chemical Cinnamic Aldehyde can be obtained. The major constituent of Cinnamon bark oil is also Cinnamic Aldehyde but due to its high price, it is not isolated but the entire oil itself is prized for its refined odour in expensive perfumes. The leafoil is a source of Eugenol which is also present in Clove oil. In view of the fact that Cinnamon trees thrive well in India the development of the Cinnamon oil industry from the bark as well as the leaf is an immediate possibility. In Ceylon there is a thriving industry in Cinnamon Oil and the export from Ceylon of both the bark and leaf oils amount to nearly 200,000 lbs. per annum of the value of about Rs. 4 lakhs. The total world production of Cinnamon oil comes to nearly 360,000 lbs., and it will be seen the important part that the Cinnamon Oil plays in the economic life of Ceylon. At the Kerala Soap Institute, Calicut, the oils from the bark, leaves and buds from the Mangalore forest have been extracted and the samples presented to us were of an excellent quality. The yield of oils obtained at this institute were also promising. When Cinnamon trees are available in India and their cultivation can be extended, there is no reason why a Cinnamon oil industry in India cannot be successfully established. We understand that even the bark of the Cinnamon trees in the Indian forests is not tapped; the bark is an important culinary and medicinal ingredient.

(20) *Citrus Oils*.—(*a*) A promising start on a small scale in the production of Citrus Oils has been made at Utran in East Khandesh, Bombay Presidency, and at Renala Khurd, Montgomery District, Punjab. The approximate production and prices at present are given below :

	Quantity produced. Lbs.	Price per lb. Rs.
(d) Orange oil (Citrus Aurantium Linn).	356	9 to 12
(c) Lime oil (Citrus Medica Acida)	Figures not available.	10 to 14
(b) Lemon oil (hand pressed) (Citrus Limonum).	381	10/8
(a) Grape fruit oil (Citrus Decumana Linn).	28	16
(e) Santhra oil (Citrus Nobilis Lour).	150	12

We understand that these oils find an immediate sale in India itself. The manufacture of the oils other than Lime was undertaken after considerable research at the Chemical Laboratories of the Punjab University particularly on the cultivation of the best type of citrus fruits for the production of essential oils and on the most economical and efficient methods of extracting, purifying and stabilising the oils. We consider that this collaboration between the producer and the University is the most encouraging sign of the times and we should like to see this example followed by other Universities for giving an industrial and practical bias to the scientific researches conducted under their auspices. The manufacture of Lime Oil was also undertaken after a careful investigation of the problem by the Department of Industries, Bombay. The lime tree is indigenous to India and grows throughout the country. In Bombay Presidency the area under cultivation is estimated to be 1,200 acres. The oil is distilled by steam from the rinds and juice of the fruits and it is reported that on an average about 2 per cent of oil is recovered The Lime Oil is used as a flavouring material for food and beverages and there is demand for it both in Europe as well as the United States. At present most of the Lime Oil is supplied by the West Indies and its pre-war price in London market varied from 21*sh.* to 44*sh.* per lb.

(b) The development of citrus oils in India on a large scale will be of great benefit to the country and if a reference is made to the production of Citrus Oils in the small island of Sicily it will be seen how far behind India is in this matter. Sicily and Calabria are but small pieces of land as compared with India; according to Parry, the Italians took seeds, seedlings and grafts of citrus trees from India for their plantations but as a result of organised cultivation the annual production of citrus oils in Sicily in 1935, according to Schimmel, were as follows :

	Sicilian lbs.
Bergamot oil	7,50,000
Lemon oil	25,00,000
Orange oil	6,00,000
Total .	38,50,000

N. B.—1 Sicilian lb.=8 oz. Avoidrupois, (approximately).

The value of these oils came to about Rs. 4 crores and it shows the importance the Italian Government attached to the cultivation and development of this industry on this large scale. In India, Oranges, Sweet Limes, Lemons and Grape fruits grow in a number of places. The Central Provinces, the Punjab, the North Western Province, the Khasi Hills in Assam, the Sheveroys and the Wynads on the Western Ghats, the Bamra State in Orissa and Coorg are important centres of cultivation of Citrus trees. The following varieties of Citrus plants are recorded as being grown in India; alongside their names, we have indicated the

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varieties of essential oils that can be obtained from either the peals, the flowers or the leaves.

Names of trees.	Essential oils available.
(1) Citrus Bigaradia Risso (Bitter Orange)	Petit grain oil from the leaves. Bitter orange oil from fruits.
(2) Citrus Aurantium Linn (Sweet Orange —"Narangi".)	Oil of Neroli Portugal from flowers Oil of sweet orange from fruits and rind.
(3) Citrus Nobilis Lour (Mandarin or Maltese Orange).	Oil of Mandarin leaves from leaves. Oil of Mandarin from fruits.
(4) Citrus Decumana Linn (Paradise apple—"Batabi Limbu".)	Grapefruit oil from fruit peel.
(5) Citrus Medica Linn (The Citron)	Oil of Linnette leaves from leaves. Oil of Citron from fruits.
(6) Citrus Limonum (Lemon—"Kaghzi")	Oil of lemon from fruits.
(7) Citrus Lemetta (sweet Lime—"Mitha Limbu"	Oil of limmette flowers from flowers. Oil of limmette from fruits.
(8) Citrus Acida (sour lime—"Limbu")	Oil of lime from fruit.

Italy was until lately the main source of supply of Citrus Oils; but California and very recently Palestine have succeeded in developing this industry. The Citrus Oils are indispensable in the manufacture of fine perfumery, but their largest use is as a flavouring material in foods, confectionery, aerated waters and tobacco. At present in all the Citrus plantations in India a considerable quantity of fruits is allowed to rot and go waste. If an attempt were made to recover the oil from the peels of these wasted fruits a considerable additional income would accrue to the plantations. The extraction of Citrus oils from the peel is closely connected with the utilisation of the wasted fruit in the manufacture of marmalades, fruit juices, syrups, etc. Considerable scope, therefore, exists in the development of this industry, and we are, therefore of the opinion that steps should be taken to develop the manufacture of Citrus oils, Citric Acid and Pectin at the Orange and Lemon plantations in India so that not only new industries but new wealth may be created in the country. India imports annually over a hundred tons of Citric Acid of the value of about Rs. 1·25 lakhs; it also imports Sodium and Potassium Citrates, and about 18,000 lbs. of Lemon Oil of the value of Rs. 94,000. The total of these imports alone therefore come to cover Rs. 2·5 lakhs and there appears to be a scope for the immediate development of these industries. A certain amount of work on the extraction of oil from the peels of the sweet Orange (Santhra) has been done at the Kerala Soap Institute, Calicut, and it should not be difficult to encourage some of the planters in Wynad and in Coorg to undertake experimental distillation of the oil from Orange peels. According to the Kerala Soap Institute, the cost of distilling the Orange Oil will not exceed Rs. 2 per lb., which compares very favourably with the pre-war price of imported oil of Rs. 5 per lb.

(21) *Eucalyptus Oils*: (Eucalyptus Globules Lab.)—This oil is obtained from the leaves of the Eucalyptus trees which thrive well on the Nilgiris, the Annamalai and the Palni Hills. The area under cultivation on the Nilgiris is about 2,550 acres whilst the production of oil is nearly 22,000 gallons per annum, equivalent to about 85 tons. At the current rate of

Rs. 1-8-0 per lb. of Eucalyptus oil the value of Indian Eucalyptus oil comes to nearly Rs. 3 lakhs. The entire production is consumed within the country and in addition India imports about 2,000 gallons of Eucalyptus oil of the value of about Rs. 25,000 from Australia. The Eucalyptus trees in the Nilgiris are however, steadily disappearing as they are being rapidly used up as firewood. We are unable to understand why this state of affairs is allowed to exist and it appears to us that the importance of Eucalyptus oil has not been fully realised. We recommend that early steps be taken to see that new Eucalyptus trees are being continuously planted on the Nilgiris where the old trees are cut down for firewood, as otherwise the Eucalyptus Oil industry will totally disappear. We also understand that U. P., Bihar as also certain tracts in Orissa are suitable for Eucalyptus plantation and as Eucalyptus oil has commerical importance, it would be of benefit to the country if its cultivation on large scale is undertaken in these areas. Cultivation may be also undertaken of another variety of Eucalyptus tree known as Eucalyputs Citriodora; the leaves of this variety are reported to be rich in citronellal which is an important aldehyde in perfumery as well as in medicinal industry and is also a starting medium for the manufacture of menthol. The manufacture of Eucalyptus Oil is conducted by primitive methods as a result of which the purity of the oil varies from batch to batch. It is stated that Indian Eucalyptus Oil is deficient in its cineol content and therefore does not come up to the latest B P. specification. We see no reason to neglect the Eucalyptus Oil indusrry due to the newly imposed B. P. specification as the Indian oil is of good quality and aroma. It contains 60 per cent. cineol by volume, which is sufficient for all ordinary use. The Indian oil besides contains no aldehydes, such as valeric, butyric and caproic aldehydes, the presence of which causes irritation to the throat resulting in coughing and other unpleasant symptoms, which is the case with the Australian oil, which, in our opinion, needs further rectification to remove the aldehydes. Moreover, the yield of oil obtained in the Nilgiris even by primitive, methods is reported to be greater than the yield from Australian leaves of the same botanical name

(22) *Geranium Oil*: (Pelargonium graveolens and odoratissima).—This oil is distilled on a small scale, about 600 lbs. per annum, at Yercaud on the Sheveroy Hills, from a variety of French geranium probably P. Odoratissima. We have examined the oil and found it to be of a very good quality. The first plantation of Geranium Rosat was planted in Yercaud on the Sheveroy Hills, near Salem in South India, by a Frenchman named Mons. Sens on his estate He was one of the pioneers in the manufacture of essential oils, for in addition to planting Geranium Rosat, he also planted Orange, Patchouli and Jasmine with a view to develop an essential oil industry in India. He, however, sold his plantation after about 10 years and the development of what might have been an interesting industry came to an end as the present owners of the estate are more interested in growing coffee than manufacturing essential oils. Distillation of Geranium oil on a small scale under controlled method is still being carried out at this estate and it is reported that an acre of Geranium Rosat yields about 8 lbs. of oil: the present price of oil is Rs. 25 per lb. Puran Singh had also found a profuse growth of wild Geranium in certain localities on the Nilgiris and had investigated the oil from the leaves and flowers. Geranium oil is an oil of great importance in the perfumery industry as, along with Khus and Patchouli oils, it

forms the body of all good perfume compounds. It is also the basic medium for the manufacture of Rhodinol and its esters. The world production of Geranium oil is estimated at about 150 tons, the bulk of which comes from the Reunion Islands and Algeria. The Nilgiris and the Sheveroy Hills are well suited for the cultivation of Geranium plants, and India can produce a Geranium oil of first class quality, which will have not only a market in India but also a large market abroad. Care will have to be taken to see that the right variety of Geranium is planted as there are 6 or 7 species of Geranium, and certain varieties yield an oil which gives a peppermint note and which may not be acceptable to the perfumery industry, which always prefers an oil having a predominant rose odour and without any subsidiary odours. Geranium can be cultivated on the Nilgiris and Sheveroy Hills in the existing plantations alongside with Coffee and Oranges, and as a result of larger cultivation, even if the oil were to fetch a price of only Rs. 10 to Rs. 12 per lb., which was the normal pre-war price, the sale of Geranium Oil will give a profitable subsidiary income to the planters.

(23) *Ginger Grass Oil :* (Cymbopogon Caesius : Stapf).—Ginger Grass grows wild in some of the southern districts of Travancore where it is known as " Inchipul ". There are two varieties of this grass, one white and the other red, but the oil from both the varieties is similar in respect of odour as well as other qualities. The oil is distilled by crude methods from leaves, grass and flowers on a very small scale and hardly 4,000 lbs. of it are obtained in a year. Ginger Grass Oil is a sweet smelling oil and Dr. Moudgil of the Travancore University, who examined the oil, has stated that it is different in constituents from Lemon Grass and Palmarosa Oil, although it resembles Palmarosa Oil in odour. Ginger Grass oil is useful for cheaper varieties of soap blends and it would be therefore, worthwhile to develop the distillation of Ginger grass oil on a larger scale.

(24) *Khus Oil*: (Vettiveria Zizainoides).—This oil is distilled from the roots of the Khus grass which grows in abundance in widely different part of India, *viz.*, in Malabar, Orissa, the Punjab, Central Provinces, United Provinces and Bharatpur State. The grass grows wild and no systematic effort has been made to cultivate it or to find out its varieties or which of them will yield the best quality or the highest percentage of oil. The distillation of the roots is carried out by primitive methods on a fairly large scale in Bharatpur and in the United Provinces and to a small extent also in the Punjab and in Orissa, but no attempt has been made to extract the oil so far in Malabar. In the Punjab, it is reported that nearly 60 to 70 thousand maunds of roots of grass are available every year, and Dr. J. L Sarin of the Government Industrial Research Laboratory, Punjab, has reported that the yield of oil from the Punjab grass was 0 4 per cent. according to which nearly 20,000 lbs. of Khus oil can be distilled in the Punjab alone. Subsequent experiments have shown that the figure of 20,000 lbs. is rather high and it would be more accurate to estimate the oil at between 7,000 to 10,000 lbs. No information is, however, available as to the quantity of Khus Oil produced in the Punjab at present and to what extent the available grass is being used, but as far as our enquiries go the production of the oil in the Punjab is negligible. The distillation at Bharatpur and in the U. P. is generally carried out by distillers from Kanauj, who go to the grass growing centres and distil

the oil on the spot. According to Kanauj distillers, the production of Khus oil in Bharatpur and U. P. will be between 6 to 7 thousand lbs. per annum. The season for the distillation of oil is from November to February and it is reported that the oil from Bharatpur is of a heavier type and suitable for soap making, whilst that from the U. P. particularly from Moosanagar, is said to be of a delicate type suitable for the perfumery industry. This would suggest that there must be two varieties of grass growing in these tracts and only a systematic study can show whether the claim of the Kanauj distillers is justified The Bharatpur oil is quoted at Rs. 40 per lb. as against the price of Rs. 80 per lb. demanded for the Moosanagar Oil. It has been brought to our notice that during the last two years there has been considerable reduction in the distillation of Khus Oil in Bharatpur due to the enhancement of the State Octroi duty on the grass from Re. 0-8-0 per maund to Rs. 1-8-0 per maund. As the price of Khus root is only about Rs. 2 per maund the levy of an Octroi on it of as much as Rs. 1-8 0 per maund is a heavy impost, and we would urge the Bharatpur Government to reduce this Octroi in order to encourage the distillation of this important essential oil on a wider scale. Khus Oil is an important ingredient in the perfumery industry and in view of the fact that the grass grows wild in many tracts of India, we are of the opinion that a systematic study of the different varieties of Khus grasses should be made so that only the best type of grass may be cultivated We also believe that the distillation of the oil by more modern methods on a larger scale in all the grass growing areas will be of considerable benefit to the country. Khus Oil has not only a large market in India itself but has possibilities of an export trade, if an oil of standard quality were to be produced. We estimate that at present Khus Oil worth Rs. 3 lakhs is being produced annually in India and even if the production were to be doubled, we do not anticipate any serious difficulty in finding a market for the increased production. At present India imports from Java and the Reunion islands a certain quantity of Vetivert Oil. The Indian Institute of Science, Bangalore, have examined the chemical properties of the Indian Khus oil and the imported Vetivert oils and have found negligible differences. The quality of the Indian Khus Oil is often considered really suitable for all perfumery purposes.

(25) *Lemon Grass Oil.*—(Cymbopogon Citratus, Stapf). This grass grows mainly in the northern districts of Travancore and in a small area in Cochin on an elevation of about 500 feet. Formerly, the grass was also found in central and southern districts of Travancore but this has now ceased. The cultivation of the grass is very haphazard and scattered over large areas, some of which are highly inaccessible. Lemon grass is a hardy plant and grows in almost any kind of soil, though it is reported that the more fertile the soil, the more the citral content in the oil. The life of the grass varies from 6 to 15 years, but 8 to 10 years is the normal productive life. The sowing of the grass takes place towards the end of March or beginning of April and it is reported that the best yield of oil is obtained when the grass is cut during the dry weather. Normally, there are four cuttings in the year at an interval of 6 to 7 weeks starting in May and ending with December. The distillation of the grass is carried out in old fashioned stills, but at the Kerala Soap Institute at Calicut, where the oil was distilled under scientific methods, they were able to obtain an oil of a lighter colour and finer odour than the oil

obtained by ordinary crude methods. The Tata Oil Mills Co., Ltd., where also similar experiments were conducted some years ago, corroborated that they were not only able to get a paler colour oil, but the citral content of their oil was as high as 85 percent. against the average 77 per cent. of the bazaar oil. The oil is brought for sale at Kothamangalam, Alwaye and Moovattupuzha, all in Travancore, and the rate is fixed by the shippers who are the chief buyers of the oil. There is a small consumption of the oil in the country and the bulk of it is exported to Europe and America from Cochin. The export of the oil is on the increase and whilst 216 tons of oil were exported in 1925, the export had gone up to 390 tons in 1938. The price of Lemon Grass oil varies between 1*sh.* 3*d.* to 2*sh.* 3*d.* per lb. c. i. f. London, but the price of the oil at present is about Rs. 2 per lb. *ex*-Cochin and on an average production, of 350 tons per annum, its total value comes to about Rs. 15 lakhs. We are indebted to Messrs. Pierce Leslie & Co., Ltd., Cochin, who are important exporters of the oil, for the above information.

The importance of Lemon Grass Oil to Travancore can be gauged from the fact that in the year 1920 its production was valued at only Rs. 42,000 per annum, while in 1927-28, when the price of the oil was as high as Rs. 5 per lb., it went up to as much as 39 lakhs. This high price led the French and Italian Governments to develop the cultivation of Lemon Grass in their African colonies, with the result that in the French African colonies alone, the production of Lemon Grass Oil went up from 21,000 lbs. in 1920 to 1,12,000 lbs. in 1935 We are indebted to Mr. N. S. Warrier of the Travancore University for this information. This increase in production has contributed to a fall in the prevailing prices of Lemon Grass Oil, but even at the present prices the cultivation of Lemon Grass is of importance to the agricultural economy of Travancore. The widespread cultivation of Lemon grass is an example of a valuable subsidiary income to the agriculturists from a secondary crop, the raising of which we cannot too strongly emphasise. With an improved method of distillation and the maintenance of a standard quality, there is no reason why the Lemon Grass oil industry should not prosper and increase in extent and scope. We understand that the Industries Department of the Travancore Government have made a start with providing the villagers with a better type of still with a view to obtain a more standard quality of oil. Recently it was reported that some of the samples of the Indian Lemon Grass oil were insoluble. The solubility of the oil in 70 per cent. alcohol is considered by the Perfumery trade as a criterion of its purity. Dr. Moudgill and Mr. N. S. Warrier of the Travancore University, therefore, investigated the causes of the insolubility and found that it was due to the presence of a different grass in the true Lemon grass. This grass is like lemon grass in appearance but has a white stem and is usually called the white variety. As it is found to give a higher yield of oil it is cultivated with true lemon grass, but its harmful effect to the purity of the Lemon Grass oil had not been realised. These workers have also reported that the oil from the white variety is entirely different from Lemon Grass oil since it has no citral content, is insoluble in 70 per cent. alcohol and contains only 10 per cent. of aldehydes. We were glad to learn that the Travancore Government had taken steps to eliminate the admixture of the white grass with true Lemon grass and thus maintain their position in the world market as one of chief producers of pure Lemon Grass Oil.

(26) *Linaloe Oil.*—(Mexican variety; Bursera Delpechiana. Bursera aloexylon). This oil is produced at Tanguni Estates about 11 miles from Bangalore from the carpels, though the oil can sometimes be distilled from the leaves as well as the wood. The distillation of the oil is carried out with modern stills under scientific control. About 20 years ago, nearly 220 acres of land were planted at Tanguni Estate with Linaloe trees and as these trees take a number of years to grow the distillation of oil has only started few years back. The oil produced at the estate is of an excellent quality and can be satisfactorily used in the blending of many a perfume for the soap industry. The present production is reported at about 1,200 lbs. per annum, but as the trees grow older it will be possible to distil a larger quantity. The present price of the oil is Rs. 12 per lb. and prior to the war, the bulk of the oil was being exported as we were given to understand that it was turned down by the soap makers and other perfumers in India. Due to the present stoppage of imports the Indian soap makers have, however, now started using this oil in their blends. We consider that Linaloe Oil has great possibilities and the extension of Linaloe plantation should be encouraged. The important aromatic constituent of Linaloe oil is Linalol from which it is possible to make Linalyl Acetate, an important aromatic chemical for the perfumery industry.

(27) *Palma Rosa or Rosha Grass Oil.*—(Cymbopogon Martini, Stapf.) This oil is produced from the Rosha Grass which grows abundantly in the Central Provinces, Bombay Presidency, in some parts of the Nizam's Dominions and is also found in Baroda, Gwalior and Indore States, but it is reported that no attempt has been made in any of these States to distil the oil. The late Mr. Puran Singh introduced the grass in the Punjab and started a model plantation on a cottage industry basis. The grass is said to be known in India from ancient times and until recently India was the only source of supply of this oil. The production of the oil is estimated by Schimmel at about 40 to 50 tons per annum, but this appears to us to be an exaggerated figure. Palma Rosa oil used to be exported to Europe where it was valued on account of its principal aromatic constituent, Geraniol, which is present in the oil to the extent of about 90 to 95 per cent., but during recent years Indian manufacturers of soaps and toilet articles have also started to use the oil in the blending of their perfumes. Rosha Grass is a perennial plant; it grows to a height of about 6 to 8 feet. It is grown from seeds which are generally sown in the month of June before the monsoon starts. In 4 to 5 months the grass is ready for its first cutting and distillation. The oil is distilled from the entire grass including the flowering stalk, the leaves and flowers yielding most of the oil. Prof. Luthra of the Punjab Agricultural College and Research Institute of Lyallpur, who has made an investigation on Rosha Grass states in his note on the "Essential Oil grasses of India" that there are 11 varieties of Rosha grass of which the "Motia" variety is the best from the point of view of yield of oil and fragrance; the other varieties yielding poor quantity as well as quality of oil. An acre of grass yields 15 to 20 lbs. of oil, but according to Prof. Luthra the Punjab does not provide the best conditions for growing Rosha grass, as the Punjab is subject to severe frost which kills the grass and reduces its oil content to as much as 54 per cent. The late Mr. Puran Singh, realising the importance of this oil for the perfumery industry, persuaded the Punjab Government to give him a grant of land for the experimental cultivation of palma Rosa grass. He was granted 400 acres of land in Chenab

Canal, near Lyallpur, in 1924, where he cultivated this grass over 230 acres, and from which 3,000 to 3,500 lbs. of Palma Rosa oil are distilled annually. Mr. Rakshit, who visited this farm, has reported that the land given to the late Mr. Puran Singh appeared to be deficient and also suffered from the handicap that while the Punjab Government charge a ground rent of Rs. 11-8-0 per acre including water charges for wheat crops Puran Singh's Rosa Grass plantation has to pay a ground rent of Rs. 17 per acre including water charges. We recommend that the Punjab Government be requested to reduce the rent to the same level atleast as wheat particularly as it is a model farm, which deserves Government encouragement and support. Mr. Rakshit also found that the plantation "has more than one kind of grass, which requires careful isolation, development and analysis of oil to ascertain which variety of grass yields most valued oil with the ultimate object of multiplying the important type and gradually replacing the rest". We concur with this view as we believe it to be vitally important to the Palma Rosa oil industry that only the best variety of grass be grown, which, according to Dr. Luthra, is the Motia variety. At present the grass grows in a wild state in the forests and is often inaccessible for exploitation. As India holds an important position in the supply of Palma Rosa oil, we are of the opinion that the cultivation of Rosha Grass be carried out on most scientific lines and attention be paid by the Industries and Agricultural Departments to improve the methods of cultivation as also of distillation We have learnt that the Dutch Government have started a systematic cultivation of Rosa Grass in Java from seeds taken from India and if it proves to be a success, India will lose what little export trade it has in the Palma Rosa oil and we invite the attention of the Agricultural Departments to this problem. The price of Palma Rosa Oil before the war varied from Rs. 5 to Rs 6 per lb.; this was the price of the Motia variety; the inferior of " Sofia " variety fetching a lower price of Rs. 2 to Rs 3 per lb.

(28) *Rose Oil.*—(Rosa Damascena, Linn). This is a very important oil for the perfumery industry, but it is totally ignored and neglected in India at present. The Rose Oil of India or as it is more popularly known, the Otto of Rose, was known all over the world in olden days and had the reputation of being of the finest quality. Not only has India lost its position to the Balkan countries, which are to-day the biggest producers of the Otto of Rose of some of the finest qualities, but the production of Rose oil for internal consumption also has been neglected totally and to-day not more than 5 to 7 lbs. of it are produced in India as against 6 to 7 thousand lbs. produced in the Balkan countries particularly Bulgaria. Even to-day the small quantity of Rose Oil that is produced in India is almost as good as the Bulgarian Rose oil and it is of vital importance to the country that the manufacture of Rose oil in India should be undertaken on a much larger scale than hitherto. Ghazipur, which was once known all the world over as the centre of Indian Rose Oil, now produces roses on a very small scale on account of the degradation of the species and the impoverishment of the soil and the centre of gravity for the production of Rose oil has shifted to Barwana in Aligarh District of U. P. The season for roses in Barwana lasts for only six weeks from the middle of March till the end of April, and it is reported that during this period as much as 200 maunds of rose petals are distilled per day and at the height of the season, which lasts for only about a week, the arrivals of flowers come to as much as 1,000

maunds per day. Most of the rose petals are, however, used up for the manufacture of Rose attar and only about 5 to 7 lbs. of pure Otto of Rose is produced per annum The distillation at Barwana is carried out by distillers from Kanauj by old methods and it is reported that about 13,000 lbs. of rose petals give about 1 lb. of Rose oil (which means a yield of about 0·008%, this is addition to Rose water which is obtained in the process.) If a more modern method of distillation is adopted, it should be possible to obtain a higher yield. Even with the present methods, were all the rose petals in Barwana to be used up for the distillation of Otto of Rose and not of attar, the production of Rose oil could be increased to atleast 50 lbs. per annum. Systematic study of the manufacture of Otto of Rose by modern methods has been carried out by the Industries Department of the United Provinces and they have stated that the yield of oil can be raised to as much as 0·015 per cent. by using an improved type of still, *i.e.*, we can obtain from the existing crop of flowers at Barwana twice as much more oil than what the crude method of distillation yields. If the Government of the United Provinces were to set up a demonstration still of a modern design at Barwana and show by practical demonstration to the distillers the advantages of improved methods of distillation, permanent result of great benefit to the industry can be obtained. We consider a wider cultivation of roses and a production of Otto of Rose to be of immediate and considerable importance to India. We understand that in South India as much as 125 acres are under Rose cultivation, but no attempt has yet been made there for distilling Rose Oil, and we invite the attention of the Industries Department of the Government of Madras to carry a systematic investigation of the Roses grown in their area in order to find out whether they are suitable for production of a fine quality of Rose Oil. If the results of the investigation are encouraging it should be possible to induce some of the Rose cultivators to set up a small distilling unit for the production of Otto of Rose. So far as our information goes Rose Damascina is the only suitable variety for the distillation of the oil, but a systematic study of the different varieties of Rose grown in India may reveal that some of the other varieties may be equally suitable for distillation We cannot too strongly recommend the development and extension of rose cultivation in India on a wider scale, as the price of Rose Oil from the Balkans range from Rs. 600 to Rs. 1,000 per lb. and the importance of Rose Oil to Indian economy can be easily gauged.

(29) *Sandalwood Oil.*—(Santalum Album). Sandalwood oil is obtained from the wood of the Sandal trees which grow largely in the forests of Mysore, Coorg and Bombay Presidency. The wood is commercially valued according to size, weight, physical appearance, etc., and has varied domestic uses. The wood is rich in oil and according to the research carried out at the Forest Research Institute, Dehra Dun, the oil is found in both billets and roots. The wood is generally disintegrated into small fine powder before it is taken to the still for the extraction of the oil. The manufacture of Sandalwood oil is conducted chiefly in Mysore and on a moderate scale at Kuppam, Mettur, Bombay, Kanauj and Karkal (S.K.) Most of the Sandalwood oil factories operate modern stills with steam and the quality of the Indian oil is approved all over the world. There are, however, some factories in Mangalore which still extract the oil by crude methods of distillation, but their production is

negligible and they are thus of no importance. According to Mr.S.G. Sastry of the Government Sandalwood Oil Factory, Mysore, it was only during the last world war when the export of Sandalwood to Europe was cut off that the Government of Mysore took the logical and correct course of manufacturing Sandalwood Oil in Mysore for export, rather than exporting the wood itself. The last world war thus gave an impetus to the Sandalwood Oil industry in India with the result that to-day India is not only self-sufficient for its requirements of Sandalwood Oil but has also developed a valuable export market for its oil. With the export of oil the export of Sandalwood has considerably diminished. though there is still a considerable export of the Mysore wood to America where the oil is distilled for the American market, on account of the prohibitive duty imposed by the U. S. A. Government on the import of Sandalwood oil. We estimate the production of Sandalwood oil in India at 100 tons per annum, the value of which at to-day's price of about Rs. 10 per lb. comes to Rs. 22·5 lakhs. With the development of the soap, toilet and perfumery industry and larger manufacture of pharmaceutical goods in India, there is every reason to believe that the manufacture of Sandalwood Oil will progress still further in the years to come. We notice that the British Pharmacoepia has introduced a new specification providing for a minimum of 2 per cent. Santalyl Acetate. This addition may serve as a handicap to the sale of Indian Sandalwood Oil where the B. P. specification is insisted upon and we should like to draw the attention of the Sandalwood oil manufacturers to this factor lest they may not be taken unawares.

(30) *Salersin or Chua Oil.*—(Shorea Robusta). This oil is extracted by crude methods in Cuttack from Sal resin which is an exudation from Sal trees which grow in Orissa. No systematic investigation appears to have been made of this oil and we are unable to state whether and to what extent it can prove useful in the perfumery industry. The Director of Development, Orissa, has, however, reported that investigations were carried out by him for improved methods of manufacture of this oil, but on trial it was found that the oil produced in an improved still was thinner than the oil produced by the crude method and as such did not command any market. A systematic investigation of this oil would be desirable as it is reported that some years ago, as much as 1,000 lbs. of oil was extracted every day and was consumed by Kanauj distillers in the manufacture of incenses and attars. The sample of the oil that was submitted to us was, however, not satisfactory, and we are unable to express an opinion on its value to the perfumery industry.

(31) *Turpentine Oil.*- (Coniferae family). The oil of Turpentine is obtained by steam distillation of Oleo Resin which exude from various pine trees which are tapped at regular intervals by incision. Three factories, one at Jallo in the Punjab and another at Bareilly in U. P. and a third in Kashmir are carrying out the manufacture of Turpentine Oil. The production of Turpentine Oil at the Bareilly factory is reported to be about 160,000 gallons (*i e.*, about 640 tons) per annum, but the figures of the other two factories are not available, though their combined production will be much larger than he Bareilly factory. The present price of Turpentine oil varies from Rs. 4 gallon for the first grade to Rs. 2 per gallon for the 3rd grade. Though Turpentine Oil as such has no use in the perfumery industry it is an important oil of commerce for

paint and varish industries, as also in the manufacture of wax polish. Turpentine oil is also the starting material for the manufacture of Terpineol (Synthetic Lilac), the economic manufacture of which, however, depends on the Pinene contents, particularly the Alpha variety, of the oil. The Turpentine oil produced in India is unfortunately poor in Alpha pinene, the percentage of which is only under 20. Alpha pinene is also the starting material for the manufacture of synthetic camphor. The importance of camphor natural and synthetic for war industries, as well as in the manufacture of celluloid and like materials, cannot be over estimated and in para. 18 (page 12) we have dealt with the importance of developing the manufacture of camphor in India. Some investigations have been already made on the manufacture of synthetic camphor at the Harcourt Butler Institute, Cawnpore, and the Indian Institute of Science, Bangalore. It will, therefore, be in the interest of the Turpentine Oil factories to see if they cannot produce an oil rich in Pinene. There are several varieties of pine trees in India, such as "Pinus Excelsa" (in U.P.), "Pinus Khasya" and "Pinus Merkusii" (in Burma) yielding Oleo Resins as rich in Pinene as 90/95 per cent. and if they can be collected at a reasonable cost, new industries for the manufacture of Terpineol and Synthetic Camphor can be started in India

(32) *Attars.*—We have referred briefly in para. 10 (page 10) to the manufacture of attars at Kanauj. As it is an ancient art, peculiar to India, we propose to deal with it now in greater detail. Attars may be described as blends of flower oils with sandalwood oil in varying proportions ; the proportion of flower oil determines the quality of the attar and the more predominent the flowery note, the higher its price. It is reported that several lakhs of Rupees worth of attars are manufactured every year at Kanauj, but unfortunately as this manufacture is carried out on a cottage industries basis, there are no fixed standards of quality. As the attars are being gradually replaced by cheap foreign synthetic perfumes, the Kanauj attar manufacturers have resorted to the practice of adding aromatic chemicals to their blends with a view to cheapen the cost and be thus able to compete with perfume compounds from Europe. The result is, however, regrettable as the attars of Kanauj have lost their reputation for purity and quality, which they had for generations. To us it appears that the day of Indian attars is over, and though this will be regretable in some respects, we do not think that any attempt to prevent its extinction is likely to meet with any measure of success. The taste in India for perfumes is being more and more influenced by western blends and the demand for attars will be replaced by more modern types of perfumes based on typical Indian notes of sandalwood, khus, Rose, Jasmine, etc. There are about 30 makers of attars in Kanauj and they produce a variety of attars, some of them being specialities of individual manufacturers.

(33) *Henna attar.*—This is not a flower attar but is a blend of perfume produced from about twelve different ingredients consisting of essential oils and aromatic gums and resins. The formula of Henna attar is a closely guarded secret and each manufacturer has his own formula in which the ingredients as well as their proportions vary. The firm of Mohammad Ali Asgar Ali of Kanauj and Lucknow have the reputation of producing the finest quality of Henna attar. It is reported that about 12,000 lbs of Henna attar are produced per annum and the price varies from Rs. 17-8-0 to Rs 40 per lb.

(34) *Jasmine Attar.*—Jasmine grows almost everywhere in India and Mr. Rakshit has found that the following varieties of Jasmine grow or can be easily grown in the country:

1. Jasminum Auriculatum Vahl—"Juhi".
2. Jasminum Grandiflorum, Linn—"Chameli".
3. Jasminum Augustifolium Vahl—"Mallica".
4. Jasminum Humile Linn—"Malati".
5. Jasminum Officinale Linn—"Chamba".
6. Jasminum Pubescens Willd—"Kund-phul".

Grasse in France is the only biggest centre of production of Jasmine Oil of the finest quality. It is made by the enfleurage and volatile solvent methods, but in India pure Jasmine Oil is unknown and only an attar is made at Kanauj, Jaunpur, Ghazipur and Sikandarpur, all in U. P. twice a year during the flowering season, the first of which is in April. In addition manufacture of large quantities of Jasmine scented fixed oils, mostly from til seeds, is also carried out at these centres. It is, however, a short season lasting for about a month whilst the second season lasts from July to October. The present price of Jasmine flowers is about Rs. 16 per maund of 90 lbs., but the price varies according to the season, the crop and the demand for the attar. It is reported that at one time the price of the flowers had gone up to as much as Rs. 40 per maund. The out-turn of Jasmine crop in Kanauj and Jaunpur is estimated at about 18,000 lbs. per annum, and at Sikandarpur at 27,000 lbs. per annum. The price of Jasmine attar varies from Rs. 17-8-0 per lb. to Rs. 40 per lb., depending upon the quality. In the cheaper quality of attar the extract from about 6 to 8 maunds (equivalent to about 500 to 700 lbs.) of flowers is added to about 10 lbs. of sandalwood oil, whilst the superior quality is produced by storing the attar of one season for three to four years during which period fresh jasmine extract is added to it from year to year. Except for Mr. Rakshit's report we have not come across any report on the varieties of jasmine produced in U. P. and a systematic study should be undertaken with a view to cultivating flowers of the best variety. We also consider it very necessary that an immediate start be made to extract the "concrete" and "absolute" from jasmine flowers by the enfleurage method. For this purpose it would be necessary to carry out a series of researches on the different types of jasmine at present grown in U. P., the selection of the variety or varieties which gives the best results from the point of view of fragrance as well as "scent factor" and the most economic manner of extraction. The pre-war price of Grasse Jasmine concrete was Rs. 750 per lb. and that of the "absolute" Rs. 2,500 per lb. and these prices indicate the possibilities that exist in India for the development of these valuable perfuming materials which play an important part in blending perfumes of high grade.

(35) *Kewda attar.*—Kewda or Screwpine (Pandamus odoratissimus) grows in large quantities in Orissa, in the coastal districts and abundantly in Ganjam. The bulk of the Kewda flowers are used as offerings in temples or worn by women in their hair. The price of Kewda flowers is about Rs. 10 to Rs. 12 per 1,000 and the season for the flowers lasts from April to November; the annual crop is estimated at 50 lakhs of flowers. The attar is obtained by collecting the distillate, from flowers,

in sandalwood oil, by distillers from Kanauj who set up their own stills in the flowering districts. Chattrapur, Berhampur, Jagannathpur and Gopalpur are the main centres of manufacture. The price of Kewda attar varies from Rs. 17 to Rs. 40 per lb. Attempts have been made during recent years by the Hindustan Aromatics Co. to distill the pure oil from the Kewda flower which may find considerable use in the perfumery industry. A preliminary study has been made at Holkar College, Indore, on the characteristics of the oil of Kewda and we suggest a further investigation on the oil as we find the oil to contain 80 per cent. of the methyl ether of Phenyl Ethyl Alcohol which is a valuable aromatic chemical.

(36) *Mitti Attar.*—This attar is a speciality of Kanauj and is produced from Kanauj clay after it has been treated with certain processes. The treated clay is mixed with water and the distillate from it is condensed in Sandalwood oil and allowed to stand over for a period of months before it is a ready for use. The price varies from Rs. 40 to Rs. 80 per lb. The finest quality of Mitti attar gives the aroma resembling the delicate fresh smell that arises from the earth when the first shower of rain falls. The process of treating the clay and the proportion in which it is used is a closely guarded secret. The sale of this attar is limited and is restricted only to a small clientele having an acquired taste for it.

(37) *Moghra or Bela attar.*—This attar is produced from jasmine flowers of Moghra variety which also grow very largely at Kanauj, Jaunpur, Ghazipur, and Sikandarpur. The Moghra flower is a variety of jasmine but its fragrance is somewhat different to the true jasmine and the Bela attar has, therefore, an aroma quite different from that of jasmine. According to Mr. Rakshit the following varieties of Moghra are grown in India for commercial purpose :

1. Jasminum Sambal Ait, Single "Bela".
2. Jasminum Arabian, Double "Bela".
3. Jasminum Arboreseans Roxb, "Nava Mallika".

The crop of Moghra flowers in U. P. is about ten times as large as that of jasmine. At Jaunpur and Kanauj, the arrivals of flowers are estimated about 180 thousand lbs. per annum at each of these centres, whilst at Sikandarpur about 25,000 lbs. of flowers are gathered in a year. In view of the largeness of the Moghra crop the price of Moghra flowers is about Rs. 8 per maund of 90 lbs. As with Jasmine, it should be possible to extract a "concrete" and "absolute" of Moghra of a fine fragrance by the enfleurage method.

(38) *Rose attar.*—In para. 28 in dealing with the subject of Rose Oil we have already stated that Rose attar is produced at Ghazipur and Barwana. The attar is distilled from the flowers and calyxes and is very greatly prized by consumers in India. The price of Rose attar varies from Rs. 15 to Rs. 50 per lb.

(39) *Other flower attars.*—Attars from other flowers are also produced on a small scale ; for instance at Agra the Maulsari or Bokul flowers (Mimasopo Elangi) yield the exquisite Maulsari attar ; similarly the flowers of champak and Narcissus (Nargis) are also distilled for the

extraction of their attars. The demand for these attars being limited, the production is on a small scale and is carried out often only against definite orders.

(40) *Scented Waters.*—These are obtained by distillation of aromatic natural products with water and the distillate is bottled and sold for perfumery, flavouring and medicinal uses. Rose water, Kewda water, Ajwan water and Dill water are some of the principal varieties made in the country and are widely used throughout the country.

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CHAPTER III.

THE APPLICATION OF ESSENTIAL OILS AND THE SCOPE FOR DEVELOPMENT.

(41) The important users of essential oils and aromatic chemicals in India at present are :—

(1) The Soap and Cosmetic industry.
(2) The Pharmaceutical industry.
(3) Confectioners and ærated water makers, and
(4) Manufacturers of attars, perfumes, tobacco, agarbathies, etc.

(42) *The Soap industry.*—The recent bulletin of the Bureau of Scientific Research estimates the production of soap in India at 90,000 tons per annum. Separate figures are not given of Laundry, Industrial and Toilet soaps, but from our enquiries we estimate the production of toilet soap on a conservative basis at about 6,000 tons per annum. About the same quantity may be said to be produced of industrial soaps, but we shall omit any reference to them as they are not consumers of essential oils or aromatic chemicals ; the balance of about 80,000 tons of laundry soaps which together with the toilet soaps are, therefore, important consumers of perfumes. Even the village soap maker, making cold process soap on a cottage scale, uses a small percentage of perfume to mask the fatty odour of the soap. The percentage of perfume used in ordinary laundry soap may be taken at about ½ percent by weight ; for perfuming therefore 80,000 tons of Washing Soap, 400 tons or about 9,00,000 lbs. of essential oils and or perfumes are required, the value of which at even a low price of Rs. 2 per lb. comes to Rs. 18 lakhs. In toilet soap, the percentage of perfume used is much higher, and is in the neighbourhood of 1½ per cent ; on a production of 6,000 tons of toilet soap per annum, therefore, nearly 90 tons or over 2,00,000 lbs. of perfumes would be used. The toilet soap perfumes are much more expensive than those used for laundry soaps and estimating their cost at an average of Rs. 7 per lb. the value of perfumes used in toilet soaps will be over Rs. 14 lakhs. The laundry and toilet soaps, therefore, between them consume over Rs. 30 lakhs worth of perfumes, the bulk of which comes from abroad. If the soap industry's progress in India is to be maintained at the present rate, it is reasonable to expect that in the course of the next ten years, the consumption of essential oils and aromatic chemicals in this industry will double itself and if steps are not taken to develop the essential oil and aromatic chemicals industry in India, it would mean a still larger dependence of India on imported perfumes. The manufacture of cosmetics like hair oils, creams, powders, etc., needs also fairly large amount of perfumes. Hair oils are popular throughout India and as they are mostly made from crude vegetable or mineral oils, the percentage of perfumes used in them is much greater than even in toilet soaps. It has not been possible for us to collect any figures of production of toilet articles, as they are manufactured all over the country on a small scale, but considering the growing popularity of these commodities the consumption of perfumes by them will be, in our estimate, in the neighbourhood of Rs. 15 lakhs per annum.

(43) *Pharmaceuticals.*—The Pharmaceutical industry is another large consumer of essential oils. In Appendix I is given a list of essential oils

which are incorporated in the British Pharmacopoeia of 1932. Absence of statistics does not enable us to give any accurate idea of the consumption of essential oils by this important industry, but from the information that we have been able to collect through the kind assistance of the Chambers of Commerce, we find that on a very conservative basis this industry consumes no less than 60,000 lbs. of essential oils per annum and the value of which may be estimated at Rs. 3 lakhs. This figure does not take into account the requirements of Dispensing Chemists all over India whose consumption of essential oils will be another Rs. 2 lakhs per annum, making a total of Rs. 5 lakhs. In our opinion a large number of oils mentioned in Appendix C (1) can be manufactured in India, and in some cases, Indian substitutes may be just as good and can replace some of the oils, the raw materials for which are not available or cannot be grown in India.

(44) *Confectionery and Aerated Water Makers.*—The value of flavouring essences for Aerated waters and confectioners imported into India can be estimated to be at Rs. 10 lakhs per annum. The important flavouring essences used are ginger, lemon, orange, vanilla, pineapple, raspberry, rose, etc., and they are mainly derived from essential oils.

(45) *Attar manufacturers and Perfumers, etc.*—No accurate figures of the quantity of attar produced at Kanauj and other places, nor their values, could be obtained, but from the little information that we could gather, their value is well between Rs. 20 to 30 lakhs per annum. Similarly the consumption of perfumes in the manufacture of tobacco, agarbathies incenses, etc., would add another few lakhs to the total consumption of India.

(46) To summarise the position the consumption of essential oils in India at present will be nearly Rs. One crore per annum of which we can account for over Rs. 90 lakhs as follows, as our estimates have been drawn up on a very conservative basis :—

	Rs.
Soap industry	32 lakhs.
Cosmetics	15 ,,
Pharmaceutical . . . . : .	5 ,,
Confectionery and Aerated waters . .	10 ,,
Attars, perfumery, tobacco, etc. . .	30 ,,
	92 lakhs.

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(47) The results of our enquiry have shown that there are many possibilities of increasing the output of the essential oils already produced in the country and of developing many new varieties of oils from the raw materials which are already available or which can be made available by a systematic cultivation. We have already indicated in the previous chapter the possibilities of extending, for instance, the Eucalyptus, Khus and Rosha Grass plantations, of manufacturing Cinnamon, Citrus and of developing Jasmine and rose absolutes. We propose to discuss in subsequent paragraphs some of the aromatic grasses, plants and trees which can be grown in India for the development of the essential oil industry.

(48) *Grasses.*—In 1906 Stapf classified aromatic grasses into three generas :—

Cymbopogon with ten species,
Andropogon with one specie,
and
Vettiveria with one specie.

Since then new species of grasses have been discovered and the following list comprises 20 well defined species of aromatic grasses including those recognised by Stapf which are denoted by an asterisk.

* (1) Cymbopogon Caesius (Stapf) (Ginger Grass).
* (2) Cymbopogon Citratus (Stapf) (Lemon Grass).
(3) Cymbopogon Clandestinus.
* (4) Cymbopogon Coloratus (Stapf).
* (5) Cymbopogon Confertiflorus (Stapf).
* (6) Cymbopogon Flexuosus (Stapf).
* (7) Cymbopogon Jwarancusa Schult (Stapf).
(8) Cymbopogon Javarensus Hofmann.
* (9) Cymbopogon Martini (varieties Motia and Sofia) (Rosha Grass).
*(10) Cymbopogon Nardus Rendle (Citronella Grass).
(11) Cymbopogon Nervatus Chiov.
*(12) Cymbopogon Odoratus Lisb.
*(13) Cymbopogon Pendulus (Stapf).
*(14) Cymbopogon Polyneuros (Stapf).
(15) Cymbopogon Schoenanthus Spreng.
(16) Cymbopogon Senaarensis Chiov.
(17) Cymbopogon Winterianus Jowet.
(18) Andropogon Kuntzeanus Hack (Variety Foveolata closely resembling Cymbopogon Odoratus).
(19) A new specie of Andropogon which Stapf reported as coming "nearest' to Cymbopogon Jwarancusa Schult.
*(20) Vettiveria Zizainoides (Stapf) (Khus Grass).

Of the above grasses the following grow in abundance in many parts of India but they are not fully exploited for the distillation of oils :—

(2) Cymbopogon Citratus (Lemon Grass).
(3) Cymbopogon Martini (Rosha Grass).
(1) Symbopogon Caesius Stapf (Ginger Grass) and
(4) Vettiveria Zizainoides (Khus Grass).

A more systematic exploitation of these grasses and their distillation by more scientific methods will yield a considerably larger quantity of oils. Simonsen had investigated the oil from the grass Cymbopogon Jwarancusa and he found that the oil contains about 80 per cent. of Piperitone which is capable of yielding both Menthol and Thymol. As this grass can grow on the plains as well as the hills, a further study into its propagation would be worth investigation in view of the possibility of making Menthol and Thymol from its oil. The Khus Grass in the Punjab and in South India has remained untapped and their exploitation will enrich the country and give employment to a number of people. The Khus Oil produced in U. P. and Bharatpur hardly meets the need of the country and India imports Vettivert Oil from Java to make up its total requirement. This import from Java appears to us quite unnecessary when large quantities of Khus Grass are allowed to go waste in the Punjab and South India. Similarly India imports annually about Rs. 2·5 lakhs worth of Citronella Oil from Java and Ceylon. The Citronella Grass (Cymbopogon Nardus) grows to a small extent in Cochin and Travancore States and Mr. Rakshit, who tried to grow the grass in his gardens at Ghazipur, found that it could be cultivated in India without any difficulty. It would be, therefore, to the immediate advantage of India to undertake the cultivation of Citronella grass on a large scale so that it may not be necessary for the country to import its requirement of Citronella oil from Ceylon and Java after a few years. Citronella Oil is rich in Geraniol and Citronellal, particularly the Java quality and the propagation of the Java variety of grass will yield to the country a raw material for making important aromatic chemicals like Geraniol, Citronellal and their derivatives which are also imported into India for use in the manufacture of perfumes.

(49) *Gums.*—In our investigations we have found that no systematic study appears to have been made of aromatic gums In the forests of India aromatic exudations are collected and sold in their natural forms; we have reasons to believe that if these gums are properly investigated they may be found to be sources of valuable perfumery ingradients. The oleo resins derived from the natural gums are valuable fixatives of the perfumery industry, as for instance the Tolu and Peru Balsams of South America, the benzoins of Thailand, the olibanum (frankincense) from Africa and the galbanum and myrth of ancient fame.

(50) *Plants.*—(*a*) India is full of aromatic shrubs and plants. Amongst them the families of Artemisia, Ocimum, Pogostemom are valuable sources of aromatic oils. In India, except in a few cases, no serious study has been made of these plants to develop new essential oils. The investigation so far done is mainly on Ocimum family whilst the other families have remained neglected.

(*b*) *Artemisa.*—In an estate at Gudalur on the way to Ootacamund a small quantity of Worm-wood oil (Artemisia Vulgaris) is being distilled. The oil was of a good quality but it was reported that the distiller could not find an outlet for his product in India. The oil has medicinal properties and is largely used for pharmaceutical purposes and can also be used in perfumery. Another variety of Artemisia which is being cultivated on a commercial scale in Mysore is "Davana" the oil from which was distilled in Bangalore some years ago by the Essenflour Products Ltd., about which a reference had already been made. "Davana" herb is generally used in festivals and temple offerings and also for flavouring tobacco. It has a fine smell and the essential oil obtained from it is reported to have a very fine fragrance. The oil has not been systematically analysed for its chemical constituents but finds a market in America. According to Mr. S. G. Sastry the present price of this oil is said to be as high as Rs. 315 per lb. Artemisia plants grow wild throughout India on hills and a systematic study, both botanical and chemical, is necessary as some of the varieties may be found to yield delicate oils of considerable value.

(*c*) *Ocimum.*—The Ocimum plant grows in almost every part of India and if it is propagated on a plantation scale new essential oils can be developed from them which will find ready uses in the perfume industry. Mr. Rakshit had made a close study of the Ocimum plants at his gardens at Ghazipur and was able to identify the following varieties :—

No. 1. Ocimum Basilicum (Variety Album) Sweet Basil; "Marua."
No. 2. Ocimum Basilicum Crispum. Sweet Basil; "Marua."
No. 3. Ocimum Basilicum (Variety Purpurascinus) Sweet Basil; "Marua".
No. 4. Ocimum Basilicum (Variety Thyrsiflorum) Sweet Basil; "Marua".
No. 5. Ocimum Canum, "Mamri".
No. 6. Ocimum Pilosum, "Mamri".
No. 7. Ocimum Sanctum "Shree Tulsi".
No. 8. Ocimum Sanctum "Krishna Tulsi".

The University of Allahabad have subsequently done a certain amount of investigation on the Ocimum plants and they have observed that the leaves of Ocimum Canum contain as much as 68 per cent. Citral, while those of Ocimum Sanctum have Eugenol and Eugenol Methyl ether. The University of Aligarh, on the other hand, conducted a partial investigation on the medicinal use of the oil from Ocimum Sanctum as a specific for Malaria and Influenza but the work could not be concluded as the School of Tropical Medicine at Calcutta, to which the samples of oil were sent for ascertaining the therapeutic value, did not send any report and further work could not, therefore, be continued. Investigation is also being conducted at present at the Government Industrial Laboratory of the Hyderabad State on the oil of Ocimum Sanctum, but the work is not yet completed ; their Chief Chemist, however, reports that "Lavender like perfumes are also obtainable from this oil". The Kerala Soap Institute, Calicut, have examined the oil from Ocimum Basilicum and Ocimum Canum and have reported that the oils "can be used as a perfume for soaps, cosmetics and hair oils". Messrs. Karandikar Bros. of Korla, Ratnagiri District, have started distilling the oils on a small scale from Ocimum Basilicum and Ocimum Sanctum. In view of these investigations it may be reasonably expected that if the cultivation of the Ocimum plants is encouraged it will lead to the development of a new branch in the perfumery industry.

(*d*) *Lavender and the like plants.*—India imports annually about a lakh of Rupees worth of Lavender Oil mainly from France where the Lavender plants grow in abundance. Attempts have been recently made to grow Lavender plants in Kenya. The climate of India, on the Himalayan ranges and on the Nilgiris on elevations of 8,000 feet and above, is suitable for the cultivation of the true Lavender (Lavendula Vera) plants for the distillation of the oil. At lower altitudes other varieties of Lavender such as Spike Lavender (Lavendula Spica) and Rosemary (Rosmarinus Officinalis) can be successfully grown and were actually found cultivated by Mr. Goldstein on the Nilgiris and the Sheveroy Hills, from imported seeds, though no attempt has been made to distil the oil from them. Lavender can form an important subsidiary crop and the production of Lavender and like oils will be a welcome addition to the Essential oils of India.

(*e*) *Peppermint*: (Mentha Piperita).—India imports about Rs. 75,000 worth of Peppermint oil annually. There is no reason why it should not be possible to cultivate Peppermint plants in India. Peppermint oil is an important member of the Essential Oil family and has uses in the pharmaceutical and confectionery industry. We are of the opinion that the Peppermint plants of suitable varieties may grow well at altitudes of 4,000 to 5,000 feet if selected plants are introduced at these heights.

(*f*) *Pogostemoms.*—Another very important Essential oil in the perfumery industry is the Patchouli Oil obtained from Pogostemom Patchouli. There are several varieties of this plant and they grow wild in the forests of India, but no attempt has been made either to cultivate them or to extract oil from their leaves. Patchouli oil is at present imported from Malaya and Java and as reported in paragraph 14 Patchouli leaves have been recently imported from Singapore for the purpose of distillation by the Kangudi Industrial Works, Kuppam, and the Government Sandalwood Oil Factory, Mysore. We are of the opinion that there would be no difficulty to grow patchouli systematically, particularly in parts of South India where rainfall is plentiful. The Malaya variety of Patchouli was introduced by some planters at Yercaud, Coorg, Gudalur (Nilgiris) and Bangalore, and as far as our information goes its cultivation did not present any difficulty. As Patchouli plants grow quickly, it should be possible to distil the oil from the leaves of 2 or 3 year old plants. Patchouli Oil has a strong pungent smell and along with Khus and Geranium oils it forms the body of all good perfumes. Its importance to the perfumery industry is therefore considerable and until such time as Patchouli plantations take to develop in India, we recommend that Patchouli leaves be allowed to be imported into India free of import duty in order to encourage the distillation of this valuable essential oil in the country.

(51) *Roots.*—A large number of roots and Rhizomes like Turmeric. Ginger, etc., are grown in India but no attempt has been made to distil the oils from them. In Appendix D we have shown the quantity of roots exported abroad and if an attempt were made to extract the oils from these roots India can atleast be self-supporting in its requirements of the oils and essences of Ginger and Turmeric. The Indian Institute of Science, Bangalore, many years ago, carried out an investigation on the oils from the roots of Curcuma Aromatica (Kasturi Manjal) and Curcuma Zedoary (Kachooram) which grow wild in Malabar in South India. The powders from these roots have been used for toilet and medicinal purposes in South India for a long time. The Kerala Soap Institute, Calicut, followed up this work by distilling the oils on a small scale and they reported that the oils have a fine aromatic odour and suitable for use in soap perfumes. The oil from ginger root has been studied at the Indian Institute of Science and at the University of Travancore by Dr. K. L. Moudgill, who has found the oil from Indian ginger (Zingiber Officinale) of the same

quality as that obtained from ginger roots from other parts of the world, particularly from Jamaica and Africa. The main constituent of ginger oil is Zingiberene and the oil is valued in the perfumery and pharmaceutical industry as well as in beverages. As ginger grows in large quantities in India it would be advantageous if an attempt were made to distil the oil. Dr. Moudgill has also studied the oil obtained from the scrapings of ginger roots and has found that the oil is of the same quality as that from the root itself. The scrapings are at present thrown away and if they were utilised for the purpose of distillation, a valuable oil from this waste product can be recovered and will have an immediate sale in India. We also invite attention to the oils from the roots of "Motha" (Cyperus Rotundus) and Turmeric (Curcuma Longa) which need a further investigation.

(52) *Seeds.*—A number of essential oil-bearing seeds (including those from dried fruits) are grown in India but the oils from them are not produced. For example, the seeds of Cumin, Dill, Fennel, Fenugreek grow abundantly in India and are exported for the distillation of essential oils, which are valuable in pharmacy. The same remarks apply to the Corriander and the Cardamom seeds. In the case of the Corriander, the oil can be distilled both from the leaves and the seeds and the oil from the seeds has been investigated at the Indian Institute of Science and found to be also valuable to the perfumery industry. The main constituent of this oil was found to be Linalyl Acetate. The oil from the Cardamom seeds has also been studied and is useful both in the perfumery and pharmaceutical industries. As India grows a large amount of Cardamoms the distillation of its oil in the plantations would be worth investigation. The price of Cardamom oil in Europe was quoted pre-war at 100 *sh.* per lb.

(53) *Trees.*—A number of new oils from flowers, leaves and wood can be exploited if a systematic examination were made. For instance in the Citrus trees, the leaves as well as the flowers and the immature fruits (that drop naturally or are deliberately plucked) will yield oils of commercial importance such as Petit Grain oil from the leaves and the immature fruits and the Neroli oil from the flowers. Similarly the carpels from the "Tirphal" trees (Zanthoxylum Rhetsae) which grow well in the forests of Ratnagiri yield an interesting oil having a pleasant odour, resembling Orange Oil. It is reported that 200 candies of these carpels (equal to 50 tons) can yield as much as 3,000 lbs. of oil. These carpels, according to information supplied to us, used to be exported to Germany prior to the war at prices ranging between Rs. 20 to Rs. 25 per candy. A small quantity of the oil is distilled at Korla for use in Ayurvedic medicines, but if it were produced on a commercial scale, it should readily find favour with both Indian and foreign perfume manufacturers. This oil has been investigated and a reference to it will be found in Appendix B. Another oil which needs development is the Bellary Oil which is distilled on a small scale at Honnametti Estate, South India, from leaves of Bellary trees Litsae Zeylanica) which grow wild in the forests of South Kanara. An investigation was made of this oil and a reference to it will be found in Appendix B. We have examined the oil and find that it has a spicy odour and can be used satisfactorily in the blending of cheap perfumes: if it is developed on a commercial scale, we believe it will find a market both within and outside India. As will be seen from Appendix C, India imports about half a lakh Rupees worth

of Clove Oil annually mainly from Zanzibar. The Imperial Council of Agricultural Research have recently investigated the question of cultivation of Cloves In India and have published a bulletin on the subject. The results of the enquiry show that Cloves can be grown in India in certain areas and if the cultivation of Cloves is undertaken on a commercial scale, it is possible to develop the Clove Oil industry in India. Clove oil is used as a medicinal and a flavouring agent and is rich in Eugenol. The development of the Clove Oil and Cinnamon Oil which we discussed in Chapter II, para 19) in India would make the country self-sufficient in them and will also enable the production of Eugenol, in which both these oils are rich. Another oil which is imported in India is the Cajeput Oil. (Malaleuca leucadendron). In the Madras Horticultural gardens some attempts have been made to grow Cajeput trees and it is reported that they can be grown successfully and can be easily propagated. The Cajeput oil is obtained from the leaves and introduction of these trees should be encouraged. Another tree which grows quite easily in India is the Accacia Farnesiana. The Director of Industries of the Punjab is contemplating an experiment to extract oil from the Cassie flowers of these trees which are reported to be available abundantly in the Punjab. The oil obtained from the Cassie flowers is valuable in the compounding of delicate perfumes and an investigation on the extraction of oil by the enfleurage method is suggested. Similarly attempts should be made to extract oils, which, we believe, will find immediate use, from the flowers of Tuberose, Mimasops Elangi, Lotus, Surangi (Octocarpus Longifolius), Parejatak (Nyctanthis arboristis) Kamini and other scented flowers, many of which grow or can be grown in large quantities. Kashmir is known to be rich in flowers of every variety, but no attempt has been made to distil any kind of flower oils there. The Government of Kashmir have submitted to us a list of 49 oil producing plants which grow abundantly in Kashmir, but no steps have been so far taken to distil the oil from these flowery plants. We have also not come across any systematic research on the extraction of the oils from these flowers and it will be a study worth investigation, particularly as there are a large variety of Indian flowers whose oils will have a foremost value in the blending of perfumes. It would also be of value to introduce the Cananga tree (Cananga odorata) the flowers of which yield an oil valuable to the soap and perfumery industries, and which is at present imported in India from Java and Islands of Bourbon. The Cananga as well as the Cajeput trees can be grown in the forests in replacement of useless varieties. Experimental distillations have been carried out at the Government Soap Factory, Bangalore, of the woods of Chambalika and Chigatamari (Lansium Annamalayamum). The Chambalika wood oil is said to resemble Sandalwood oil in some respects and can, therefore, replace sandalwood oil, if it is available cheaply. We recommend a systematic study of this oil as it may indicate possibilities of developing a new essential oil, particularly as Chambalika trees are available in Mysore forests in large quantities and the wood may, therefore, be available for distillation at a moderate rate. The Chigatamari wood oil has been investigated at the University of Mysore and has been found to have a smell resembling cedarwood oil. The Chigatamari trees are good size trees and grow well at an altitude of 2,000 feet on the hills of Anamalais and Wynad in South India. No samples of the oils from these woods were submitted to us and we are, therefore, unable to give any comments on their value.

CHAPTER IV.

AROMATIC CHEMICALS DERIVED FROM ESSENTIAL OILS AND COAL TAR FRACTIONS.

(54) No discussion on the Essential Oil industry can be complete without adequately dealing with the Aromatic chemicals which are of vital importance in modern perfumes. Although it is not specially within our terms of reference to investigate in detail the subject of Aromatic chemicals, yet they are so closely allied to the problem of the development of essential oils that a reference to them is necessary, as sooner or later India must develop its own Aromatic Chemical industry, partly because a number of raw materials are already available in the country and partly to regulate the dependence of the country on foreign supplies.

(55) Essential oils in the ultimate are nothing more than compounds of various aromatic substances produced by the greatest organic chemist of the world, *viz*, "Nature". Some of the aromatic chemicals that are used in the modern perfumery industry are extracted from the essential oils themselves of which they form an important constituent if not an integral part ; others are found in them in such small quantities that their extraction becomes unremunerative and the Chemist in his laboratory has directed his attention to synthesising them from coal tar and thus developing an important new industry from the bye-products of coke oven. The success which the Chemist met in his laboratory has led to the discovery of new aromatic products which have, so far as we are aware, remained unidentified in nature. Since the isolation of aromatic chemicals and their manufacture by synthesis new types of perfumes are being continuously created so that there is no perfume compound to-day which has not one or the other Aromatic chemical derived either from an Essential oil or as a synthetic product.

(56) By themselves aromatic substances are complex organic chemical compounds, but when they are mixed with natural products like essential oils they become perfumes. In modern perfumes therefore Essential oils and Aromatic chemicals go hand in hand; one cannot exist without the other. To-day aromatic chemicals can be produced to give a scent typically characteristic of leaf, flower or fruit or an aroma which may baffle even the highly developed olefactory sense of the connoisseur. Between nature and the laboratory there is, therefore, a close link, and as science progresses this link will be strengthened still further for the creation of new perfumes. In cheap synthetic perfumes of to-day the aromatic chemicals play an important role largely due to the intensity of their odour; they also play an equally important part in the manufacture of flavouring essences.

(57) We mention below some of the important aromatic constituents that can be readily derived from Essential oils and some of the isolates of superior quality, used as such in the blending of five perfumes :—

(*a*) Cinnamie Aldehyde from Cassia oil.

(*b*) Citral from Lemongrass Oil.

(*c*) Citronellal from Citronella Oil.

(*d*) Eugenol from Clove and/or Cinnamon leaf oil.
(*e*) Geraniol from Citronella and/or Palmarosa Oil.
(*f*) Linalol and Linalyl Acetate from Linaloe Oil.
(*g*) Rhodinol from Geranium Oil.
(*h*) Santalol from Sandalwood Oil.
(*i*) Vettyverol from Khus Oil.

It will be seen from this list that apart from Citronella Oil, all the other oils are available to a certain extent in the country and is therefore within the realm of immediate possibility to make a start with the manufacture of the above isolates in India. It would be interesting to compare the rate of the isolate with that of the oil from which it is derived. For instance, Indian Lemon Grass Oil fetched before the war a price of Re. 1 per lb., whilst its isolate "Citral pure" was quoted in Europe at 13 sh. (Rs. 8·66) per lb. Similarly the Indian Palmarosa Oil was sold at Rs. 5 per lb., whereas the Geraniol derived from it was quoted in Europe at 24 sh. (Rs. 16) per lb. These are only the most important isolates of these oils ; there are also other isolates present in these oils in smaller proportions and they have also a commercial value. It will be obvious that India suffers an enormous loss by the export of these oils and importing instead from abroad their isolates at amazingly high prices. We attach in Appendix G a conservative estimate, arrived at from our investigations, of the quantity and value of important aromatic chemicals imported as such into India prior to the war. In addition to these, there is a large import of the value of Rs. 9 lakhs comprising of compounded perfumes and synthetic essential oils.

(58) The isolates mentioned in the previous paragraph can be transformed through chemical reactions into various aromatic compounds. A few instances of such derivatives are indicated below :—

(*a*) Cinnamic Aldehyde from Cassia oil yields Cinnamic Alcohol.
(*b*) Citral from Lemon Grass oil yields Nerol and/or Ionone and Methyl Ionone.
(*c*) Citronellal from Citronella Oil yields Citronellol or Hydroxy Citronellal and Isopulegol from which synthetic Menthol can be obtained.
(*d*) Eugenol from Clove and Cinnamon leaf oil yields isoeugenol from which can be derived Vanillin.
(*e*) Geraniol and Citronellol from Palma Rosa and Citronella oils yield various esters such as Acetates, Butyrates, Formates, Propionates, Valarianates, etc.

(59) We have indicated above the possibilities of deriving aromatic chemicals from Indian essential oils and the wide field of economic research it will open up. In Appendix B we have collected as far as possible a list of works done in Indian laboratories on Indian essential oils. In Appendix H we give a chemical classification of aromatic constituents found in essential oils of Indian plants, trees and grasses.

(60) It is not our intention to give a detailed account on Aromatic chemicals derived from coal. We only intend to enumerate some import-

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ant chemicals that can be prepared from coal. The establishment of an industry in India for making coal tar derivatives is assured of success on account of the growing demand for odoriferous materials as a result of the devlopment of the soap and allied industries. The raw materials required for this industry are available or will be produced in the country with the development of the heavy chemicals industry. We have yet not come across any scientific publications of significance from Indian laboratories on aromatic derivatives from coal tar and the subject is so vast that it can be fruitfully investigated.

(61) The carbonisation of good quality coal at high temperature for steel manufacture produces a considerable amount of combustible gases which carry along with them other components of coal, *viz.*, Ammonia, Tar and Benzol. The gases are used for the heating of the furnaces but before they are utilised for this purpose it is the practice to deprive them of tar, Ammonia and hydrocarbons (crude benzol) that are present in them. It is estimated that one ton of coal yields about 2½ gallons of crude Benzol and 5 gallons of tar ; we are not giving the figures of Ammonia produced as it does not form part of this subject.

(62) *Crude Benzol* —This product is roughly 9 per cent. of the weight of coal used and is mainly constituted of cyclic hydrocarbons of which benzene is predominant, followed by toluene and xylenes. The composition of crude Benzol is roughly as follows :—

(*a*) Benzene	65—70%
(*b*) Toluene	20—25%
(*c*) Xylenes	3—5 %

and they can be obtained by fractional distillation of crude Benzol; of these three Toluene is the most important for the perfumery industry. We give below the aromatic chemicals that can be derived from the above fractions :—

(*a*) *From Benzene* :—

(i) Chlorobenzene which is used in various reactions in which the aromatic phenyl group C_6H_5 has to be introduced.

(ii) Nitrobenzene having the flavour of bitter almonds and which can be used in cheap toilet soaps.

(*b*) *From Toluene* :—

(i) Acetophenone and Methylacetophenone.

(ii) Anthracilic Acid and Methyl anthranilate.

(iii) Benzylchloride which is the starting material for numerous aromatic chemicals like Benzaldehyde, which in its turn is also a starting material for various odoriferous molecules.

(iv) Benzyl Acetate.

(v) Benzyl alcohol and their esters.

(vi) Benzoic Acid and their esters.

(vii) Benzeledene Acetone.

(viii) Benzophenone.

(ix) Diphenyl methane.

(x) Alpha Amyl cinnamic aldehyde.
(xi) Cinnamic Acid, Alcohols and their esters.
(xii) Bromostyrol.
(xiii) Phenyl acetic acid and ethers.
(xiv) Phenyl Acetic Aldehyde.
(xv) Phenyl Ethyl Alcohol, etc., etc.

(c) *From Xylenes* :—

(i) The various synthetic musks in crystals as nitro derivatives; the three important ones are :—
  (*a*) Musk Ambrette.
  (*b*) Musk Ketone.
  (*c*) Musk Xylene.

(ii) The various phthalic acids and phthalic anhydrides. The ethers derived from the latter are important perfumery fixatives since they all have high boiling points.

(63) *Tar.*—The composition of tar is somewhat more complex; it may be considered as a mixture of phenols, heavy hydrocarbons such as Naphthalene and Anthracene, and pitch which constitutes the major portion, When tar is submitted to distillation the following fractions are obtained :—

(*a*) Carbolic Acid and Naphthalene . .	8%
(*b*) Cresylic Acids and Naphthalene . .	22%
(c) Anthracene	10%
(*d*) Pitch	60%

We propose to deal with fractions (*a*) and (*b*) only since they are sources of aromatic products.

(i) *From Carbolic Acid* :—

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(*a*) Diphenyl Oxide.
(*b*) Salicylic Aldehyde and Coumarine.
(*c*) Salicylic Acid and ethers.
(*d*) Anisol and phenetol (synthetic aniseed oil).

(ii) *From Naphthalene* :—

(*a*) Paracresol which is important in the perfumery industry as it yields various ethers some times acting as a base and some times as an acid. The important ones are the Paracresol acetate and Paracresol phenyl acetate.

(*b*) Anisic Aldehyde etc., etc.

(iii) *From Cresylic Acids.*

(*a*) Phthalic Acid and Anhydride. Incidentally we may point out that these items are not available at present even from America. They enter in the manufacture of special resins used in air craft production, the resins being the condensation products of Phthalic Anhydride and Glycerine. Some ethers of Phthalic Anhydride are used as plasticisers in cellulose paints whilst others are perfumery materials.

(*b*) Naphthols, particularly Beta Naphthol from which are derived Yara Yara, Neroline, acetonaphthone, etc.

(64) In Appendix G we have marked 18 items with an asterisk to show that these aromatic chemicals are derived from coal tar and their importance in modern perfumery cannot be overlooked. We are of the opinion that steps should be taken to start the manufacture of these synthetic products, the raw materials for which are already produced in the country by coke manufacturers.

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CHAPTER V.

RECOMMENDATIONS.

(65) In the previous chapters we have presented the data that we could gather in the short space of time on the "present position of the essential oil industry in this country". Our first reaction as a result of our investigation has been that this subject is grossly neglected and we have indicated in a brief and general manner the possibilities that await the development of the essential oil and aromatic chemical industries in India. In the subsequent paragraphs, we are recommending the steps that should be taken to further their growth and development on co-ordinated lines in order that the progress may be reasonably rapid.

(66). Our recommendations are as follows :

(*a*) A comprehensive survey should be immediately conducted under the direction of the Board of Scientific and Indusrtial Research, by a Special Officer who should be asked—

(i) to investigate the possibilities of growing aromatic grasses, plants and trees in different parts of India as a secondary crop with a view to give subsidiary occupation to the agriculturists, who, for eight months in the year, are generally idle. For the purpose of this survey this Officer will have to work in co-operation with the existing Agricultural, Botanical and Forest Departments, including those of the Indian States.

(ii) to prepare a botanical list of the existing aromatic trees, plants and grasses whether cultivated or growing wild in the country, together, with the areas covered by them and the approximate quantities available. If a proper enquiry were conducted into the commercial potentialities of the available trees, plants and grass we believe that Industrial interests in India will come forward for the purpose of their utilisation.

(*b*) An Essential Oil Advisory Committee should be created as an adjunct of the Board of Scientific and Industrial Research to advise the Board and through it the Commerce Department of the Government of India as to the lines on which work should be conducted for the development of the Essential Oil industry in the country. The Advisory Committee may consist of representatives of—

(i) Agricultural, Botanical, Forest and Industries Departments of Government.

(ii) Industrialists preferably those intrested in Essential Oils and aromatic chemicals and,

(iii) Scientific workers.

We consider a Committee consisting of the following persons as best suited for the task.

(1) The Director of the Board of Scientific and Industrial Research.

(2) One representative from the Forest Research Institute, Derha Dun.

(3) One representative from the Imperial Council of Agricultural Research.

(4) One representative from the Botanical Department of the Government of India.

(5) Two Directors of Industries of Provincial Governments preferably of Madras and the United Provinces, as these two Provinces are important essential oil producing areas at present.

(6) Two representatives from Indian States, preferably one Director of Industries and one Scientific worker.

(7) The Director or the Professor of Organic Chemistry of the Indian Institute of Science, Bangalore, and one other Scientific worker from an Indian University or Research Institute.

(8) Mr. J. N. Rakshit and

(9) Four Indian Industrialists.

(*c*). The functions of this Advisory Committee shall be—

(i) Exploratory,

(ii) Research,

and

(iii) Commercial utilisation and advice.

(i). The exploratory function of the Committee would be to investigate the economic and commercial aspects of developing new Essential Oils in the country on the lines indicated by us in chapters II annd III. The representatives of the Agricultural, Industries and Forest Departments on the Committee can render considerable assistance in the investigations as they would be able to advise with their expert knowledge what the possibilities are of cultivating new aromatic plants, the areas in which they can be cultivated and what assistance the Provincial and State Governments can render for the furtherance of the programme of development, which will necessarily have to be on well laid out plans, to achieve any measure of success. We do not wish to fetter the discretion of the Committee by any pre-conceived notions but as an example of encouragement that the Provincial and State Governments can give we would urge, Government assistance, in the early stages, to the agriculturists for the cultivation of new plants by—

(*a*) allotting tracts which may be uncultivated at present at a nominal rent,

(*b*) supplying water on advantageous terms,

(*c*) furnishing selected seeds and seedlings free of cost,

(*d*) instructing on the best methods of cultivation,

(*e*) creating Co-operative Credit Societies for collecting the crops centrally and disposing of them to distilling factories,

(*f*) arranging loans on easy terms to enterprising agriculturists who are prepared to erect a still on their own farm, and

(*g*) training them in the technique of extraction and distillation and rendering such technical assistance as may be necessary etc.

(ii). On the research side, the Committee will have to undertake a systematic study, with the assistance of Research Institutes and Universities in India, of all aromatic grasses, plants, trees, flowers, roots, seeds, growing in India and of which we have recommended the preparation of a comprehensive botanical list in our recommendation (*a*). These studies will be made with a view to determine the aromatic constituents and their properties. The work that has been done at present at the various

Universities and Research Institutes is in the majority of cases of an elementary nature and has been invariably done without the objective of an economic exploitation. This defect will have to be remedied if the scientific investigations are to render any effective assistance to the industry. The Committee will also recommend research grants to scientific workers for suitable research for the development of new essential oils and aromatic chemicals for the perfumery industry. It will also initiate field experiments at the model farms which we are recommending subsequently for the cultivation of new aromatic plants. The laboratory research of the Committee should be conducted as far as possible in a central garden laboratory which we are recommending, later on, to be set up under the direction of the Director of the Board of Scientific and Industrial Research.

(iii). Finally the function of the Committee will be :

(*a*) to co-ordinate the results of the researches at the model farms and at the central garden laboratory or elsewhere and to find an outlet for the new oils or aromatic chemicals amongst various Indian consumers as also for export;

(*b*) to explore the commercial utilisation of the results of the researches. The collaboration of the Indian consumers in this work will be of considerable importance, as their experiments with new oils and aromatic chemicals may indicate such modifications that may be necessary to make them acceptable for exploitation;

(*c*) to make a start with collecting statistical data on the present position of the industry in as many details as possible in order that the Committee may be in a position to judge the growth of the industry from time to time. We cannot too strongly deplore the present paucity of statistical information which has considerably hampered our work and has made our task of analysis and deduction very difficult.

(*d*) The creation of an up-to-date Central Laboratory with a garden attached to it. This laboratory will carry out the programme of work laid down by the Advisory Committee, under the administrative control of the Director, Board of Scientific and Industrial Research. In making this recommendation we are guided by the example of the Government of the United States whose Bureau of Plant Industry of the Department of Agriculture carefully regulate the essential oil producing plantations; in France, similarly, an Agricultural Research Station is maintained for the study of the technology of essential oils, the therapeutically active substance in aromatic plants and the generation of odours. The Laboratory will—

(i) conduct research on essential oils and aromatic chemicals in general.

(ii) evolve a standard method of analysis and standard analytical data for essential oils and aromatic chemicals ;

(iii) make a systematic study of the various aromatic plants from the agricultural point of view. For this purpose the Laboratory will set up model Agricultural farms in suitable centres where different types of aromatic plants can be grown on an experimental basis according to the suitability of climate and soil. These model farms should be also equipped for the production of the Essential oils from the plants grown on the farm with a view to study the optimum conditions of manufacture. The model farms should also act as Demonstration centres for introducing and imparting knowledge to the agriculturist in the cultivation of aromatic plants and the production of essential oils from them. With the help of the model farms it may be possible to reorganise the existing essential oil producing centres by showing them ways and means of improving and expanding their cultivation where necessary and of adopting modern methods of distillation, with a view to an improvement in the quality of the oils produced and the maintenance of standard qualities;

(iv) act as a clearing house for the disbursement of the latest information on essential oils and aromatic chemicals and issue certificates of test to recognised manufacturers for maintaining uniform standards of quality of their various products. We wish to lay particular stress on the question of quality and standards in order that a reputation be established for the Indian oils in the world markets. To-day there is much left to be desired both in the quality of oils and their method of distillation. It should be remembered that the export markets will continue to demand oils conforming to certain specifications based on their principal aromatic constituents and unless some sort of central control is established to check the quality of the oils, the progress of the industry will be greatly handicapped. For instance, Indian Lemon Grass Oil is sold in Europe and America at present on a guaranteed citral content of not less than 77 per cent. a standard which is desirable and can be easily maintained by a proper laboratory control. The Central Laboratory can therefore do a great deal to improve the conditions of the industry.

(*e*) The Government of India, with a view to further the growth of the Essential Oil industry, should follow the example of some of the more progressive Governments in other parts of the world and permit the import of raw materials that cannot be grown in the country immediately, free of import duty, in order that their distillation may be carried out in the country. We have already mentioned in our report that the Government of United States allow the import of Sandalwood into America free of duty but levy a high customs duty on the import of Sandalwood Oil. Patchouli leaves, in our opinion, deserve free importation into India until such time as they are grown in the country. The Advisory Committee can recommend to the Government of India from time to time the list of raw materials that should be imported duty free. We wish to make it clear that the import of duty free raw materials should apply only to such raw materials that are not available at present or which cannot be, for some reason or other, grown in India. As and when such raw materials are produced in the country the concession of duty free imports should be withdrawn.

BOMBAY;
8*th November*, 1941.

P. A. NARIELWALA
J. N. RAKSHIT

APPENDIX "A".

A list of persons, Institutions and Business firms addressed to by the Committee.

(1) The Director General of Commercial Intelligence and Statistics, Calcutta.

(2) The Director, Imperial Agricultural Research Institute, New Delhi.

(3) The Director, Indian Institute of Science, Bangalore.

(4) The President, Forest Research Institute and College, Dehra Dun.

(5) The Principal, Harcourt Butler Technological Institute, Cawnpore.

(6) The Superintendent, The Kerala Soap Institute, Calicut.

(7) The Universities of Agra, Aligarh, Allahabad, Andhra, Bombay, Calcutta, Dacca, Delhi, Lucknow, Madras, Mysore, Nagpur, The Punjab, Rangoon and Travancore.

(8) The Directors of Industries of Assam, Bengal, Bihar, Bombay, Central Provinces and Berar, Madras, North-West Frontier Province. Orissa, The Punjab, Sind and United Provinces.

(9) The Directors of Agriculture (Same as in No. 8).

(10) The following Indian States: Alwar, Baroda, Bharatpur, Bikaner, Cochin, Cutch, Dewas, Gwalior, Hyderabad (Deccan), Idar, Indore, Jodhpur, Kashmir, Miraj, Morvi, Mysore, Patiala, Rajkot, Rampur, Rewa, Travancore and Udaipur.

(11) The Chambers of Commerce and Industries of Bengal, Bombay, Cawnpore, Karachi, Lahore and Madras.

(12) The Indian Chemical Manufacturers' Association, Calcutta.

(13) The All-India Soap Makers' Association, Calcutta.

(14) *Business firms and others*: Messrs. Lever Bros. (India) Ltd., Bombay; The Tata Oil Mills Co. Ltd., Bombay; Pierce Leslie & Co. Ltd., Cochin; Volkart Bros. Ltd., Bombay; Godrej Soap Ltd., Bombay; Swastik Oil Mills Co. Ltd., Bombay; Pattanwala Ltd., Bombay; Ashgar Ali Mohamad Ali, Lucknow; Government Sandalwood Oil Factory, Mysore; The Hindustan Aromatics Co., Naini, Allahabad; The Agri-Horticultural Society, Madras; Mr. A. M. D'Roza, Gudalur; The Hallacarry Estate, Coonoor; Glenand Products, Bangalore; Mr. A. Rahm Yercaud; Mr. Faisandier, Yercaud; The Indian Mildura Fruit Farm, Punjab; The Rambilas Thymol Factory, Rao, Indore; Karandikar Bros. Korla (Ratnagiri).

APPENDIX "B"

Research work done in Indian Laboratories.

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151. Notes on some Essential oils—(Perf. and Ess. Oil Rec. Nov. 1937, p. 411).

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154. Kewda Perfumes Vol. IV, No. 1—Sadgopal—I. S. J., July 1938.

155. Kewda—Sadgopal—S. P. C., May 1937.

156. Deutsche Perfumarie Zeitung—Sadgopal—25th Dec. 1937.

157. Sadgopal—S. P. C. London April 1939.

158. Cedrela tonna—P. P. Pillai and B. S. Rao (Journ. Soc. Chem. Ind. 50, 1931, T. 220).

159. Jasmin Flowers—Sadgopal (S. P. C. July 1939, p. 589).

As we were unable to obtain the original publication we have not been able to complete the necessary references.

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161. I. S. J. July 1938—Sadgopal.

162. S. P. C. London, May 1939—Sadgopal.

163. Deutsche Perfumarie Zeitung, 25th Dec. 1937—Sadgopal.

164. S. P. C. London, April 1939—Sadgopal.

165. Industrial India, March 1940—Sadgopal.

166. Vijnan, February 1941—Sadgopal.

167. What India thinks, published from Calcutta—Sadgopal.

168. Industrial India, March 1938—Mrs. Sadgopal.

169. Manufacturing Perfumer, London, June 1940—Mrs. Sadgopal.

170. Cedrela tonna—P. P. Pillai and B. S. Rao (Journ. Soc. Chem. Ind. 50, 1931, T. 220).

171. Jasmin Flowers—Sadgopal (S. P. C. July 1939, P. 589).

172. Essential oil from flowers of Kewda, Pandanus odoratissimus, By S. S. Deshpande, Calcutta University Press, 1938.

APPENDIX "C"

(1)

Statement showing the quantity and value of essential oils exported from British India during the two years 1937-38 and 1938-39.

Essential Oils.	1937-38.		1938-39.	
	Gals.	Rs.	Gals.	Rs.
Cinnamon	12	125	2	15
Citronella	...	...	12	70
Ginger grass	180	7,351	265	9,249
Lemon grass	90,121	7,22,845	97,920	7,13,068
Palmarosa	10,837	4,13,413	6,642	2,34,305
Sandalwood	13,259	13,86,216	9,695	9,47,318
Turpentine	95,100	95,001	1,78,117	2,13,080
Other sorts	1,509	31,084	3,727	1,08,511
Total	2,11,018	26,56,035	2,96,380	22,25,616

(2)

Statement showing the imports of essential oils into British India during the two years 1937-38 and 1938-39.

Essential Oils.	1937-38.		1938-39	
	Gals.	Rs.	Gals.	Rs.
(a) Synthetic	23,680	8,26,486	20,981	6,84,134
(b) Natural :—				
(i) Almond	82	1,755	148	5,128
(ii) Bergamot	754	49,648	873	55,884
(iii) Cajuputi	734	9,932	1,230	15,914
(iv) Camphor	6,853	16,714	4,637	10,821
(v) Clove	1,366	41,510	1,543	40,535
(vi) Dill	3	155	1	48
(vii) Eucalyptus	1,385	26,148	1,904	25,582
(viii) Lavender	1,328	82,022	1,771	1,02,580
(ix) Lemon	1,055	49,613	1,986	93,729
(x) Otto Rose	16	2,350	15	3,399
(xi) Peppermint	1,705	70,710	1,683	67,292
(xii) Turpentine	67,125	1,10,869	31,210	44,195
(xiii) Other sorts	29,117	4,45,164	32,210	4,85,315
Total	1,35,203	17,33,076	1,00,192	16,34,556

N.B.—1 gallon = 9 lbs.

"Figures taken from the Annual Statement of the Seaborne Trade of British India."

APPENDIX "D".

Export in quantity and value from India of Essential oil-bearing Raw materials for the years 1937-38 and 1938-39.

Name of material.	1937-38		1938-39.	
	Quantity in tons.	Value in Rupees.	Quantity in tons.	Value in Rupees.
(a) Wood—				
Sandalwood	1,002	10,08,867	647	6,53,743
(b) Seeds—				
(i) Ajama	177	46,729	140	43,684
(ii) Ajwan	23	5,535	24	4,769
(iii) Aniseed	97	12,981	115	17,291
(iv) Cardamom	660	31,51,691	579	21,22,190
(v) Coriander	6,151	9,27,893	6,353	8,65,301
(vi) Cummin (other than black)	1,162	5,79,096	1,404	5,34,388
(vii) Cummin (black)	167	44,368	126	31,876
(viii) Fennel	808	2,17,425	974	,26,733
(ix) Fenugreek	866	2,34,240	1,227	2,41,328
(x) Dill	237	55,097	355	73,488
(xi) Other sorts	659	4,32,001	500	2,26,868
Total ..	11,000	56,07,056	11,800	43,87,916
(c) Roots—				
(i) Ginger	1,049	6,45,691	1,714	7,91,597
(ii) Turmeric	3,658	10,05,720	3,627	10,17,805
Total .	4,707	16,51,411	5,341	18,09,402
(d) Flowers—				
Cloves	6	9,392	3	5,429
e) Bark—				
Cinnamon	16	16,351	25	13,896
(f) Gum—				
(i) Benjamin	3	1,603	5	2,860
(ii) Olibanum	9	4,265	11	7,075
Grand Total ..	16,743	82,98,945	17,832	68,80,321

APPENDIX "E"

Approximate World Production of Important Essential Oils in quantity and value and showing the countries of origin.

Name of the oil.	Country of origin.	Annual production.	References	Value per lb. (mostly taken from Chemist and Druggist December 10, 1938, p 652).		Total value.
				s.	d.	Rs.
American Wormseed or Chenopodium oil.	United States	30 tons	Schimmel's Report, 1934, p. 102.	10	3	4,82,000
Anise oil	Russia	25 tons (?)	Ditto	2	0	78,000
Australian Sandalwood oil	Australia	30 tons	Ditto	14	6	6,82,000
Bay oil	West Indies	10 tons	Ditto	4	9	74,500
Bergamot oil	Calabria (170 tons) U. S. and Guinea (experimental).	170 tons	Ditto	15	0	40,00,000
Cajuput oil	Dutch Indies (90 to 100 tons) Annam (5 tons).	375 tons	Schimmel's Report, 1932, page 7.	2	6	14,70,000
Champhor oil	Japan (300 tons). Formosa (1,200 to 1,500 tons).	4,500 tons	Schimmel's Report, 1934, page 102.	130	0 per cwt.	81,90,000
Cananga oil	Java	22 tons	Schimmel's Report, 1938, page 12.	4	3	1,47,000
Cassia oil	China (100 to 200 tons), Java (2 to 5 tons) and Ceylon (5 to 6 tons).	200 tons	Schimmel's Report, 1934, page 102.	3	4	10,46,000

Cedarwood oil ..	U. S. A. (100 tons), Morocco (4 to 5 tons) and Italy (0·1 ton).	115 tons	Schimmel's Report, 1934, page 102, also 1938, page 148		1	9	3,15,500
Cinnamon leaf oil ...	Ceylon (50 to 60 tons) and Seychelles (40 tons).	160 tons	Chemist & Druggist, December 10, 1938, page 648		2	6	6,27,000
Citronella oil ...	Ceylon (500 to 700 tons), Java (1,000 to 1,200 tons) and India (5 to 10 tons).	2,500 tons	Schimmel's Report, 1938, pp. 18 to 25.		1	6	58,80,000
Coriandar oil ..	Russia (30 tons), Germany, U. S. A., England, Hungary, Italy, Czechoslovakia (?).	35 tons	Schimmel's Report, 1934, page 102.		14	6	7,96,000
Clove oil ..	Madagascar and European countries	250 tons	Ditto ...		6	0	22,85,000
Eucalyptus oil ...	Australia (400 tons), Spain (80 to 100 tons). Italy (0·25 to 0·5 ton) and India (?)	500 tons	Ditto ..		1	2	9,15,000
Gautheria or Wintergreen oil.	United States ..	35 tons	Ditto ...		7	6	3,12,000
Geranium oil ..	Reunion (80 tons), North Africa (20 to 30 tons), Grasse (2 to 3 tons), Spain (1 to 2 tons) and Russia (3 to 5 tons).	150 tons	Schimmel's Report, 1938, pages 51-52, also 1934, page 102.		21	0	49,40,000
Jasmine oil ..	S. France, North Africa and Palestine	* between 1 & 2 tons		£93	10	0	+27,92,000 −55,84,000
Juniper berry oil ..	Czechoslovakia (5 to 10 tons), Hungary, Yugoslavia, Germany and West Indies.	10 tons	Schimmel's Report, 1934, page 102.		4	0	62,700
Lavender oil ..	France (80 to 100 tons), Spain (2 to 3 tons) and Italy (10 tons).	115 tons	Ditto ..		10	0	18,03,000
Lemon oil ..	Sicily and Calabria (700 tons), U. S. A. (100 to 125 tons), Martinique (0.6 ton) and Madagascar (0·1 ton).	900 tons	Schimmel's Report, 1938, pages 36 and 60.		11	0	1,55,23,000

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* Approximate figures calculated by us on the basis of a yield of 0·1%.

Name of the oil.	Country of origin.	Annual production	References	Value per lb. (mostly taken from Chemist and Druggist, December 10, 1938, p. 652.)		Total value.
				s.	d.	Rs.
Lemongrass oil ..	India (150 to 270 tons), Madagascar (40 to 50 tons) and Martinique (0·4 to 0·5 ton).	350 tons	Chemist and Druggist, January 28, 1933, page 100.	2	2	11,89,000
Lime oil	West Indies ..	40 tons	Schimmel's Report, 1934, page 102.	17	6	10,98,000
Linaloe oil ..	Brazil (100 tons) and Guiana (15 to 20 tons).	100 tons	Ditto ..	8	0	12,10,000
Neroli oil ..	France (1·5 ton), Algeria and Tunis (0·2 to 0·5 ton), Italy (0·25 to 0·4 ton) and Spain (0·1 to 0·2 ton).	2·5 tons	Ditto ..	25 per oz.	0	15,68,000
Orange oil sweet ..	Sicily and Calabria (fell from 100 to 25 tons), Guinea (100 to 120 tons) Jamaica (30 tons), California (25 tons), Spain (10 to 15 tons), S. Africa (10 to 15 tons) and Brazil (0·5 ton).	400 tons	Schimmel's Report, 1934, page 102, also 1938, page 62 and page 73, and other reports of Schimmel & Co.	5	0	31,36,000
Orange oil bitter ..	Sicily and Calabria (25 tons) and Jamaica (5 tons).	25 tons	Schimmel's Report, 1934, page 102.	5	0	1,96,000
Origanum oil ..	Spain (25 to 30 tons), Italy (5 to 10 tons) France and Palestine (?)	130 tons	Schimmel's Report, 1938, page 74.	5	0	10,19,000
Orris-root oil ..	France and Germany ..	2 tons	Schimmel's Report, 1934, page 102.	48	0	1,50,500
Palmarosa oil ..	British India ..	40 tons	Ditto ..	7	3	4,55,000

Patchouli oil ..	Malay States and Straits Settlements (15 to 20 tons) and Seychelles (3 to 5 tons).	35 tons	Schimmel's Report, 1938, page 77. Chemist and Druggist December 10, 1938.	9 6	5,21,000
Peppermint oil ..	U. S. (350 to 400 tons), Japan (250 to 300 tons), Italy (100 to 120 tons) Russia (10 to 20 tons), France (20 to 30 tons) and England (5 to 10 tons).	850 tons	Schimmel's Report, 1934, page 102.	8 0	1,06,62,000
Petitgrain oil ..	Paraguay (80 to 90 tons), France (1 to 2 tons), Italy (0·5 to 1 ton) and Algeria (0·25 to 0·5 ton).	92 tons	Ditto ...	3 0	4,33,000
Pimento oil ..	West Indies ...	5 tons	Ditto ...	7 6	58,800
Rose oil ..	Bulgaria (2 to 3 tons), Turkey (0·3 to 0·6 tons) and Italy (0·1 to 0·15 tons)	3·5 tons	Ditto ...	50 0 per oz.	43,90,000
Rosemary oil ..	Spain (70 to 100 tons) and Yugoslavia (10 to 15 tons). France (5 to 10 tons)	125 tons	Ditto ..	3 3	6,37,000
Sage oil ..	......	11,000 lbs.	Schimmel's Report, 1938, page 94.	4 6	35,000
Sandalwood oil East Indian.	India (Mysore) (70 to 80 tons) and European countries (?).	112 tons	Drug and Cosmetic Industry, May 1941, page 540.	20 0	35,12,300
Sassafras oil ..	....	50 tons	Schimmel's Report, 1934, 102.	4 0	3,13,600
Schin or Ho oil ..	Japan ..	100 tons	Ditto ..	3 0	5,21,000 (approx.)
Spike Lavender oil ..	Spain (125 to 150 tons), France (25 tons) and Italy (?)	175 tons	Schimmel's Report 1934, page 102.	7 0	18,52,000
Staranise oil ..	Hong Kong (100 tons) and China (300 to 400 tons)	600 tons	Schimmel's Report, 1932, page 5.	3 4	31,36,000
Thyme oil	Spain (25 tons), France (0·5 to 1 ton), Italy and Palestine (?).	30 tons	Schimmel's Report, 1934, page 102.	4 8	2,12,000
Vetivert oil ..	Reunion (6 to 15 tons) and Java (5 to 10 tons).	30 tons	Schimmel's Report, 1938, page 105.	15 0	7,05,600
Ylang Ylang oil ..	Manilla (0·7 to 0·8 ton), Madagascar 15 to 20 tons) and Reunion (2 to 3 tons).	24 tons	Schimmel's Report, 1934, page 102.	1 6 per oz.	9,03,000
	Total ..	13, 968 tons		Total ...	9,87,10,500

APPENDIX "F"

A few important manufacturers and shippers of Essential Oils and Attars of India.

1.	Rambilas Thymol Factory, Rao, Indore	Ajwan Oil and Thymol.
2.	M. D'Roza, Gudalur, S. India	Artemesia Oil
3.	Ashgar Ali Mohd. Ali, Lucknow	Attars.
4.	Devi Prasad Sunderlal, Kanauj	Attars.
5.	Mathura Prasad Suraj Prasad, Kanauj	Attars.
6.	Sitharam Ayodhya Prasad, Kanauj	Attars.
7.	The Hallacarry Estate, Coonoor	Camphor and Camphor Oil.
8.	The Indian Mildura Fruit Farms, Punjab	Citrus Oils.
9.	Manakchand Kisondas, Utran, E Khandesh	Citrus Oils
10.	Gordandas Khimjee Asher, Mangalore	Cinnamon Oil.
11.	Pandya Jivanlal Mayashankar & Co. Mangalore	Cinnamon Oil.
12.	P. Narayan Vaijappa Bhandari & Sons, Mangalore	Cinnamon Oil.
13.	South India Cash Trading Co., Ootacamund	Eucalyptus Oil.
14.	The Hindustan Aromatics Co., Allahabad	Flower Oils.
15.	A. Rahm, Yercaud, S. India	Geranium Oil.
16.	Fr. Faisandier, Yercaud, S. India	Geranium Oil.
17.	Diwanchand Kewda Supply Co., Chitrapur	Kewda Oil.
18	Govindram Khasi Ram, Chitrapur	Kewda Oil.
19.	The Asiatic Essential Oil Works, Ellenabad	Khus Oil.
20.	The Manmohan Perfumery Works, Ellenabad	Khus Oil.
21.	Makkar Pillai, Alwaye, Travancore	Lemon Grass Oil.
22.	Pierce Leslie & Co. Ltd., Cochin	Lemon Grass Oil.
23.	Volkart Bros., Bombay and Cochin	Lemon Grass Oil.
24.	Glenand Products, Bangalore	Linaloe Oil.
25.	Sardar Ramendar Singh, Chenab Kanel, Punjab	Palmarosa Oil.
26.	Botosahu, Ranihat, Cuttack	Sal Resin Oil.
27.	Kasambhai Manji, Ranihat, Cuttack	Sal Resin Oil.
28.	The Government Sandalwood Oil Factory, Mysore	Sandalwood Oil.
29.	The Kangudi Industrial Works, Kuppam (S. India)	Sandalwood Oil.
30	Rao Sahib Chandappa Iyer, Mettur Dam	Sandalwood Oil.
31.	The South Indian Industrial Works, Kuppam	Sandalwood Oil.
32.	Lakshmi Sri Niwas Oil Mill, Karkala, S. Karana	Sandalwood Oil.
33.	The Sandalwood Oil Factory, Kanauj	Sandalwood Oil.
34.	Karandikar Bros., Ratnagiri	Tirphal, etc.
35.	Jallo Rosin & Turpentine Factory, Lahore	Turpentine.
36.	Indian Turpentine & Rosin Co. Ltd., Bareilly U.P.	Turpentine.

APPENDIX "G"

Estimated imports into India in 1938-39 of Aromatic Chemicals.

Name of product.		Quantity imported.	Rate per lb.		Value Indian	C. I. F. ports.	
		Cwts.	*s.*	*d.*	£	*s.*	*d.*
(1)	Amyl Acetate Pure ..	80	2	0	896	0	0
*(2)	Amyl Cinnamic Aldehyde Alpha	60	5	0	1,680	0	0
*(3)	Benzyl Acetate ..	360	2	4	4,704	0	0
(4)	Benzyl Alcohol ..	80	2	2	970	13	4
*(5)	Benzaldehyde free from Chlorine	40	2	11	653	6	8
*(6)	Benzyl Benzoate ..	80	3	1	1,381	6	8
*(7)	Benzyl Formate ..	7	5	6	215	12	0
*(8)	Benzophenone ..	20	6	4	709	6	8
*(9)	Benzyl Propionate ..	15	8	0	672	0	0
*(10)	Benzyl Salicylate ..	20	4	6	504	0	0
(11)	Citronellol Pure ...	60	7	0	2,352	0	0
*(12)	Coumarin Crystals ...	40	10	0	2,240	0	0
*(13)	Diphenyl Oxide ..	160	4	0	3,584	0	0
(14)	Eugenol ..	2	10	0	112	0	0
(15)	Geraniol Pure ...	100	5	0	2,800	0	0
(16)	Geraniol for Soap ..	40	4	0	896	0	0
(17)	Geranyl Acetate ...	15	6	0	504	0	0
(18)	Heliotropin ...	40	10	0	2,240	0	0
(19)	Hydroxycitronellal ..	30	9	0	1,512	0	0
*(20)	Indol ...	1	66	0	369	12	0
(21)	Ionone 100 per cent. ...	20	11	0	1,232	0	0
(22)	Ionone Alpha ..	4	15	0	336	0	0
(23)	Iso-Eugenol ...	2	12	0	134	8	0
(24)	Linalol Pure ..	20	15	0	1,344	0	0
(25)	Linalyl Acetate ...	30	11	0	1,848	0	0
(26)	Methyl Ionone ..	3	18	0	302	8	0
*(27)	Musk Ambrette ...	80	16	0	7 168	0	0
*(28)	Musk Ketone ..	20	16	0	1,792	0	0
*(29)	Musk Xylol ..	80	6	0	2,688	0	0
*(30)	Nerolin Yara Yara ..	60	4	0	1,344	0	0
*(31)	Phenyl Ethyl Alcohol ...	100	7	6	4,200	0	0
(32)	Rhodinol ...	2	12	0	134	8	0
*(33)	Skatol ...	0.25	66	0	98	0	0
(34)	Tirpineol ..	160	2	6	2,249	0	0
(35)	Vanillin ..	80	14	0	6,272	0	0
	Total ...	1911·25			50,129	1	4

N. B.—The products marked with an asterisk are obtained from coal-tar derivatives. At the rate of exchange of Re 1 = 1*s.* 6*d.* the value of this import comes to Rs. 6,83,000.

APPENDIX "H".

Chemical classification of aromatic constituents of Indian Essential oils.

N. B.—The numbers in brackets represent the serial reference numbers in Appendix B.

Hydrocarbons.

1. Aromadendrene (112).
2. Bisabolene (41)
3. Cadinene (15, 35, 103).
4. Camphene (16, 18, 20, 29, 112).
5. Carene (11, 14, 15, 27, 36, 62, 120).
6. Caryophyllene (15, 37, 103, 109, 112).
7. Curcumene (28).
8. Cymene (55, 97),
9. Dipentene (10, 42B, 97, 103).
10. Ishwarene (59).
11. Limonene (11, 17, 18, 20, 92).
12. Longifolene (7, 11).
13. Myrcene (44).
14. Ocimene (102, 128).
15. Phellandrene (30, 37, 42A and B, 49, 54).
16. Pinene (6, 7, 8, 9, 10, 11, 62, 92, 93, 102, 103, 112, 128).
17. Sabinene (10, 12, 36, 42C, 43).
18. Santalene (85).
19. Sylvestrene (93).
20. Terpinene (10, 42C, 55, 97).
21. Thujene 49
22. Zingiberene (30, 32, 55).

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Alcohols.

23. Benzyl Alcohol (73).
24. Borneol (18, 20, 92, 94, 112).
25. Citronellol (No Indian work has been brought to our notice).
26. Geraniol (17, 18, 73, 84, 86, 89).
27. Isocyperol (81).
28. Linalool (42A & B, 73, 118, 128, 140, 141).
29. Menthol (76).
30. Perillic alcohol (17, 19).
31. Phenyl ethyl alcohol (73).
32. Santalol (73, 85, 96).
33. Terpineol (6, 8, 12, 37, 92).

Aldehydes.

34. Citral (17, 141, 142, 145).
35. Citronellal (141).

Ketones

36. Camphor (28, 29, 38, 103).
37. Carvone (53).
38. Carvotanacetone,-d. (121).
39. Cyperone, -L (81).
40. Fenchone (52).
41. Ishwarone (58).
42. Menthone (76).
43. Methyl heptenone (17).
44. Piperitone, -d (14).
45. Tetrahydrocarvone, -1(121).
46. Turmerones.

Phenols and phenolic ethers.

47. Anethol (52).
48. Asarone (25).
49. Carvacrol (55).
50. Dill apiol (53).
51. Eugenol (34, 37, 141, 142, 143).
52. Eugenol methyl ether (25).
53. Safrol. (44, 128).
54. Thymol (63, 64).

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Esters.

55. Benzyl acetate (73, 172).
56. Benzyl Benzoate (73).
57. Benzyl Salicylate (73).
58. Bornyl acetate (112).
59. Ethyl cinnamate (27).
60. Ethyl methoxycinnamate (27).
61. Geranyl acetate (4, 18).
62. Geranyl tiglate (89).
63. Linalyl acetate (50, 73, 118, 128).
64. Methyl cinnamate (42B, 140, 141).
65. Methyl salicylate (90).
66. Terpinyl nonylate, -1 (6).

Lactones

67. Costus lactone (58).
68. Dihydrocostus lactone (58)

Oxides.

69. Cineol (28, 29, 30, 36, 103).

Unclassified.

70. Aplotaxene (58).
71. Asarylic aldehyde (25).
72. Azulene (48).
73. Bromstyrol (73).
74. Cadinol, -l (No Indian work).
75. Calamene (25).
76. Calamenenol (25).
77. Calameone (25).
78. Camphoracene, -n (27).
79. Clausenane, L-, B-, &-, di (80, 83).
80. Copaene (No Indian work).
81. Costene L-, B- (58).
82. Costol (58).
83. Guaiacol (73).
84. Ishwarol (59).
85. p-methoxy salicylic aldehyde (95).
86. p-methyl -tetrahydroacetophenone (5
87. Pentadecane -n (27).
88. Piperitol, -d (15).
89. Zingiberol (31).

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APPENDIX "I"

List of Essential oils incorporated in the British Pharmacopoeia 1932.

Oil of American Wormseed, see Oleum Chenopodii.
Oil of Anise.
Oil of Aniseed, see Oleum Anisi.
Oil of Australian Sandalwood.
Oil of Cade.
Oil of Cajuput.
Oil of Caraway.
Oil of Chenopodium.
Oil of Cinnamon.
Oil of Clove.
Oil of Coriander.
Oil of Dill.
Oil of Eucalyptus.
Oil of Lavender.
Oil of Lemon.
Oil of Nutmeg.
Oil of Peppermint.
Oil of Pine, see Oleum Abietis.
Oil of Rosemary.
Oil of Sandalwood.
Oil of Siberian Fir.
Oil of Turpentine.

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